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BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN
TROPICAL AGRICULTURE AND INDUSTRIES
AND THE COMMERCIAL UTILISATION OF
THE NATURAL RESOURCES OF THE
COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED
BY THE SCIENTIFIC AND TECHNICAL
STAFF OF THE IMPERIAL INSTITUTE
AND BY OTHER CONTRIBUTORS

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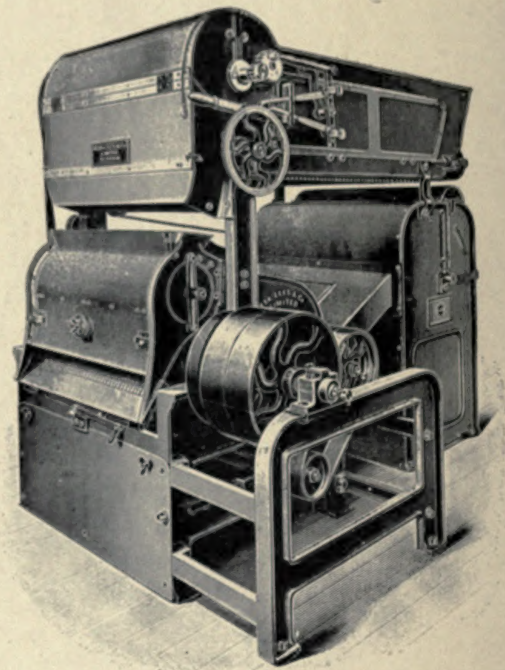

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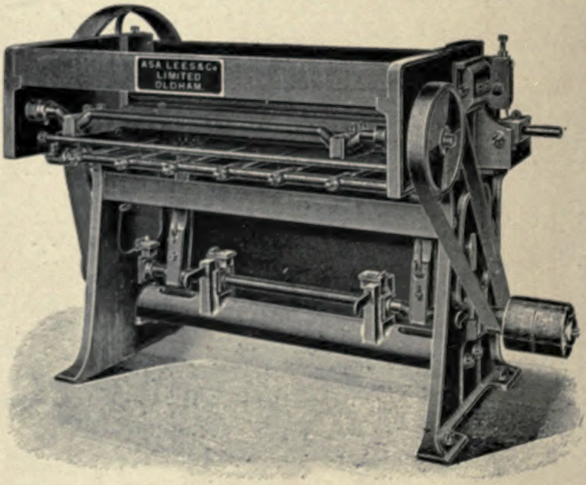

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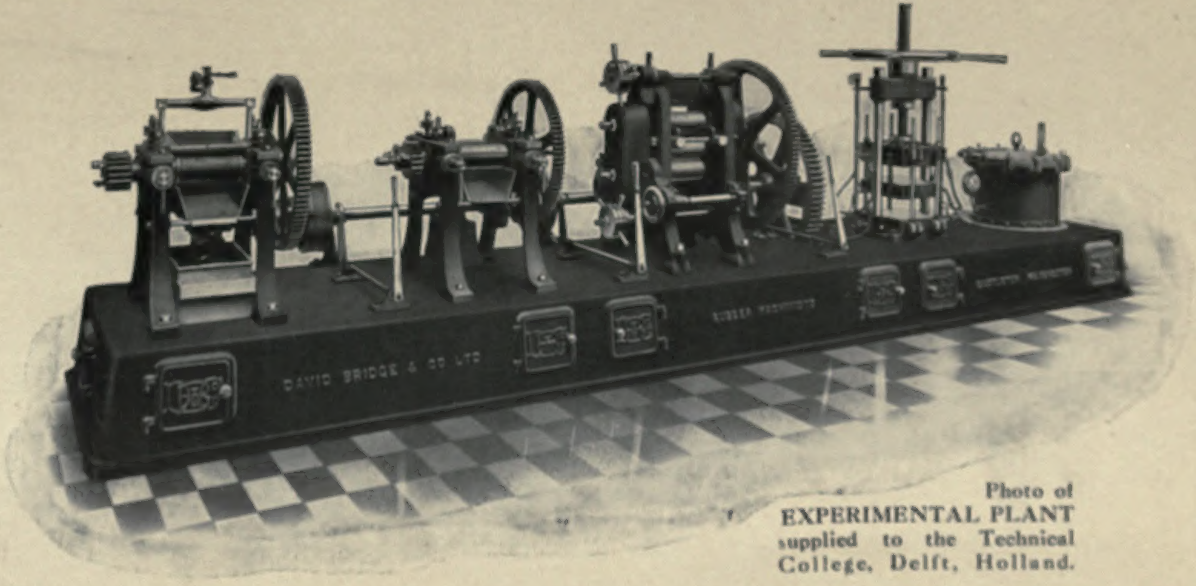

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In order to ascertain the value of the oil for various industrial purposes, samples have been distributed by the Imperial Institute to a number of firms for technical trial. It has been pointed out already (*loc. cit.*) that the cake left after expressing the oil from the kernels would probably be suitable for use as a feeding-stuff, and with a view to confirming this by actual feeding trials, supplies of the cake have been forwarded to the South-Eastern Agricultural College, Wye, so that feeding trials might be made. The results so far obtained in these two technical investigations are summarised in the following pages, to which are added the results of examination of samples of the kernels, cake, and oil forming part of experimental consignments. An account of previous samples examined at the Imperial Institute is given in this BULLETIN (1903, **1**, 156; 1911, **9**, 286).

TECHNICAL TRIALS OF THE OIL

Paint and Varnish Manufacture.—Samples of the oil were furnished to three firms for trial in the manufacture of paints and varnishes. One firm stated that the oil proved very satisfactory for their purposes, being about equal to linseed oil. They added, however, that their experiments were not carried on long enough to determine whether paint made with Para rubber seed oil lasts as long as that made with linseed oil, but they would not hesitate to adopt it in part of their manufactures, provided it was obtainable at an acceptable price. They stated that they would be prepared to pay 25*s.* to 30*s.* per cwt. for the oil if it were obtainable in considerable quantity (July 1912).

A second firm stated that the drying power of the oil was 30–40 per cent. less than that of linseed oil. They found that it dried with a "flatter" surface and considered that it would not show as good results in paint as linseed oil.

In the third case the oil was found to dry more slowly than linseed oil with the usual "driers" and to be more readily saponifiable than the latter oil. The opinion was expressed that as linseed oil was quite satisfactory for paint and varnish manufacture, it was unlikely that it could be replaced by Para rubber seed oil as long as it was obtainable at reasonable prices and in large quantities.

Linoleum Manufacture.—Four separate trials have been made with the oil for this purpose.

A German firm stated that Para rubber seed oil is not completely satisfactory as a substitute for linseed oil in the manufacture of linoleum, but that more extensive trials are necessary before a definite conclusion could be reached. They would, however, be prepared to consider the matter if the price of the oil were less than that of linseed oil.

In a second case the results were stated to be unsatisfactory. Some difficulty was experienced in drying the oil, and two manufacturers, who were supplied with samples of the oil by the firm conducting this trial, considered that it is of very little value for this trade.

Another firm stated that the iodine value of the oil is much too low to enable it to be used as a substitute for linseed oil for the manufacture of linoleum, but they expressed the opinion that it might take the place of soy bean oil for making paint oils, but this would depend on its price.

The fourth firm also considered it to be unsuitable for linoleum manufacture.

Soft Soap Manufacture.—A firm of oil seed crushers stated that the oil would be very suitable for the manufacture of soft soap, and for this purpose would be about equal in value to linseed oil or cotton seed oil.

Manufacture of Rubber Substitutes.—One firm to whom a sample of the oil was submitted thought that it would probably be suitable for the manufacture of rubber substitutes, but a second firm stated that their experiments did not show that the oil could be employed to any advantage for this purpose.

Conclusions

It has been pointed out previously in this BULLETIN (*loc. cit.*) that though Para rubber seed oil is a drying oil it dries less quickly than linseed oil and is therefore inferior to this oil for those industrial uses to which linseed oil is particularly suited. When linseed oil is high in price, however, it has to be replaced by oils that are intrinsically inferior to it for these purposes, and in such cases Para rubber seed oil would be a valuable substitute. The defects of Para rubber seed oil from this particular point of view are, however, advantages for other industrial purposes, since they enable it to be used to some extent in industries in which the employment of linseed oil is inadmissible. On the whole, the results of these trials clearly indicate that there would be no difficulty in finding a market for Para rubber seed oil, provided it can be put on the market at a suitable price and in large quantities. In this connection mention may also be made of the fact that the new process of "hardening" liquid oils by hydrogenation, if successful on an industrial scale, will open an entirely new market to oils of the Para rubber seed type (see p. 660).

FEEDING TRIALS WITH PARA RUBBER SEED CAKE

Two series of feeding trials have been carried out at the South-Eastern Agricultural College, Wye, with Para rubber seed cake, which formed part of commercial consignments imported, or made experimentally in this country and courteously furnished to the Imperial Institute by the importers.

First Series

About 4 cwts. of cake imported from Rangoon were received in February 1911. A portion was analysed at the Imperial Institute and gave the following results, to which is added for comparison the average composition of linseed cake :

	Para rubber seed cake. *Per cent.*	Linseed cake. *Per cent.*
Moisture	6·91	11·6
Crude proteins	29·93	29·50
Consisting of:		
True proteins	27·03	—
Other nitrogenous substances	2·90	—
Fat	17·68	9·50
Starch, etc. (*by difference*)	35·97	35·54
Fibre	4·82	9·10
Ash	4·69	5·20

The ash contained :

		Per cent.
Lime	**CaO**	5·03
Phosphoric acid	**P_2O_5**	33·52
Potash	**K_2O**	34·89

No saponin or alkaloids were present in the cake, and if any cyanogenetic glucosides were present the amount was less than that necessary to yield 0·01 per cent. of hydrocyanic acid.

It should be pointed out that this consignment of Para rubber seed cake was not of normal composition, inasmuch as it contained nearly 18 per cent. of fat, which is at least twice as much as would be left in the cake under ordinary commercial conditions. The composition of the second consignment (see p. 555) more closely represents the cake which would be marketed under ordinary conditions when the kernels are being expressed regularly on a large scale.

The report on the feeding trials conducted at Wye with this consignment of cake was as follows :

Cows.—A quantity of the cake was moistened and fed to cows. All except three, which are usually averse to new foods, ate it readily. The cake was dry and powdery, and was moistened before feeding for this reason. It was found to absorb about its own weight of water, and was more appetising in this state than when fed dry. Several cows refused it in the dry state, but ate it readily when moist.

Three cows received the cake daily for five days, getting 4 lb. each day. They all ate it readily, and no scouring or binding effects were noticed, nor did the milk or cream appear affected in any way.

Sheep.—The cake was fed in a dry state to sheep and was eaten fairly readily. Some sheep ate their full allowance when it was mixed with other foods, but apparently had less liking for it when fed alone. No exceptional effects were noted.

Second Series

A more extended feeding trial with 1½ tons of Para rubber seed cake, made experimentally from kernels imported from Ceylon, was carried out at the South-Eastern Agricultural College during the latter part of 1912 and the beginning of this year. A sample from this consignment was examined at the Imperial Institute and gave the following results, which are compared with the average figures for linseed cake:

	Para rubber seed cake. *Per cent.*	Linseed cake. *Per cent.*
Moisture	8·75	11·6
Crude proteins	30·19	29·50
Consisting of:		
True proteins	24·85	—
Other nitrogenous substances	5·34	—
Fat	8·71	9·50
Starch, etc. (*by difference*)	41·74	35·54
Fibre	5·01	9·10
Ash	5·60	5·20
Nutrient ratio	1 : 2·0	1 : 2·0
Food units	139	133

Cyanogenetic glucosides were present in this sample, which yielded approximately 0·02 per cent. of hydrocyanic acid.

This cake probably represents fairly closely the material which would be marketed if Para rubber seed kernels were worked industrially on a large scale, and its composition may therefore be fairly discussed in comparison with that of linseed cake, which is the feeding cake chiefly used in the United Kingdom.

It will be seen from the foregoing table that Para rubber seed cake is strikingly similar to linseed cake in composition, and that what difference there is, is in favour of the former. The chief difference is in the quantity of "fibre," which is only 5·01 per cent. in the case of Para rubber seed cake, against 9·10 per cent. in linseed cake. It is to be remembered, however, that the item "starch, etc." is a "difference" figure, and probably represents to a large extent different carbohydrates in the two cases. Thus in the case of linseed there is much mucilage, which accounts to some extent for the hardness of linseed cake. Para rubber seed cake, on the contrary, is soft and inclined to crumble easily, so that it probably contains but little mucilage. Like linseed cake, Para rubber seed cake may yield small amounts of prussic acid, and the amount furnished by this sample is rather high, but as will be shown later it produced no ill effects on the animals fed with the cake.

The following is a summary of the report received on the feeding trials conducted at Wye with this cake:

Sheep.—A group of store tegs accustomed to trough feeding were used for the experiment. The smallest admixture of the rubber seed cake with the usual concentrated foods was, however, detected by the sheep, and the cake was left uneaten. Even when the total food supplied to the sheep was reduced below maintenance requirements, and this low ration was continued for a fortnight, the sheep refused to eat the rubber seed cake. Mixtures of the cake and various other concentrated foods were also tried without success. Older sheep similarly refused the food, and in fact all attempts at feeding sheep with this sample of Para rubber seed cake failed.

Young Cattle.—The cake was fed to a pair of two-year-old fattening heifers, which readily ate the food. The quantity of cake was increased gradually to 8 lb. per head per day, but this caused pronounced scouring, and even

5 lb. of Para rubber seed cake eaten daily with 56 lb. of mangolds produced a slightly laxative effect on these immature animals; the latter quantity of cake should therefore not be exceeded, as a rule, for such cattle. Further experiments with another batch of two-year-old beasts confirmed this conclusion.

Two of the beasts were killed at the conclusion of the experiment; the butcher reported the carcases to be of first-class quality, and the beef of excellent flavour. One of these heifers had received 6 lb. of the cake per day for ten weeks.

Dairy Cows.—Six barren cows with an average milk yield of 1½ gallons per day were used for this test, and were fed with increasing amounts of the cake, until at the end of a week each animal was receiving 14 lb. of cake per day. The cake was the only concentrated food supplied to the animals, and the ration was continued for six days without any marked change in the animals' excreta. The ration being richer than that previously allowed, the yield of milk rose, but the percentage of fat in the milk was practically unchanged. Butter was made from the milk produced during the first three days and again from that of the second three, and in each instance the texture, smell, and flavour of the butter were considered to be unaffected by the change of concentrated food. The butter was of slightly paler colour than that obtained from the same cows on a concentrated food ration of bran, dried grains, oats, and Egyptian cotton seed cake.

Para rubber seed cake can thus be safely fed to dairy cows without fear of tainting the milk or adversely influencing the butter. Even the large quantity of 14 lb. per head per day seems to be without noticeable effect when fed to mature cattle.

Full-grown Fattening Cattle.—The cows mentioned above were fattened while still in milk, the daily quantity of rubber seed cake being reduced from 14 lb. to 8 lb., and 4 lb. of other cake added. The cows remained in a very healthy condition, and maintained a high milk yield until they were intentionally dried off about a month before sale to the butcher. The increase in live weight over an average fattening period of nine weeks was 1·7 lb. per cow per day, and the milk yield over the same period was 0·85 gallon per cow per day, the cows being in milk an average of six only of the nine weeks. Para rubber seed cake thus appears to be a valuable fattening food for cows, producing very satisfactory increases in weight in mature animals, and giving rise to no ill effect even when the feeding is continued for a considerable time.

The value of Para rubber seed cake as a food for cattle has been clearly established by these experiments. As the first sample of Para rubber seed cake was eaten fairly readily in a dry state by sheep (see p. 555), it would appear that the aversion of sheep to the second sample must have been due to some peculiarity which it possessed, or to some idiosyncrasy in the sheep used, and it will not be desirable to draw a definite conclusion as to the unsuitability of Para rubber seed cake as a food for sheep without further trials.

COMMERCIAL CONSIGNMENTS OF PARA RUBBER SEED KERNELS

As a result of the work done at the Imperial Institute on Para rubber seed kernels, a considerable amount of interest in this product has been aroused among planters in Ceylon and the Federated Malay States, and among oil seed crushers and others in the United Kingdom, and several experimental consignments of the kernels, oil, and cake have been received and sold in the United Kingdom. The following particulars of such a consignment of kernels crushed in the United Kingdom are of interest in this connection.

"*Kernels as received from Colombo.*"—This consisted of dried kernels in fair condition, though a few damaged kernels were present. On examination at the Imperial Institute the kernels were found to yield 45 per cent. of a pale yellow liquid oil with an acid value of 34·1.

"*Cake as received from the crushers.*"—This consisted of clean, friable, buff-coloured cake, which was found to contain 11·2 per cent. of a semi-solid oil, obviously composed principally of free fatty acids.

"*Extracted oil.*"—This was a clear, liquid, brown oil, which gave the following results on examination, compared with those for samples of Para rubber seed oil from kernels in good condition previously examined at the Imperial Institute:

	Present sample.	Previous samples.
Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$.	0·925	0·925 to 0·930
Acid value	40·9	10·7 to 16·8
Saponification value . .	188·5	191·8 to 192·1
Iodine value . . *per cent.*	143·3	125·3 to 131·4

The oil thus generally resembled the samples previously examined at the Imperial Institute. Its acidity, however, was high, and this factor was apparently the cause of the "feeding up" stated to have been observed in paint made with the oil. Experiments carried out at the Imperial Institute support this view, since the oil as received, when ground with white-lead, gave a pasty, stiff paint which did not spread well, whilst oil from which the free acid had been removed gave a paint which remained fluid and could be spread easily.

It has been found at the Imperial Institute that the acid value of the oil is usually higher when the latter has been prepared from old or damaged kernels, and it is possible that the rather high acid value in this instance is due to the use of kernels that had been stored for some time. The acidity is principally due to the condition of the seed which yielded the oil (see above); the increase from 34·1 to 40·9 being probably due to enzyme action during the crushing process.

The oil did not appear to contain any lipolytic enzyme, as its acidity did not increase on keeping, even under conditions favourable for the action of an enzyme.

SOME NEW OR LITTLE-KNOWN OIL SEEDS AND OILS

As a consequence of the high prices prevailing in recent years for most of the fixed oils and fats of commerce, much interest is being shown, especially in the British tropical dependencies, in the possibility of exploiting oil seeds of various kinds for export. A considerable number of such products have been examined during the last few months at the Imperial Institute, and the more interesting of these are dealt with in the following series of reports:

SAFFLOWER SEED FROM NYASALAND

The safflower, *Carthamus tinctorius*, L. (natural order, Compositæ), has been cultivated from ancient times in India, China, Egypt, Turkestan, and elsewhere, chiefly for the sake of its flowers, which yield the well-known rose-coloured dye. In parts of India, however, it is grown solely for its seeds, which yield an oil largely used locally for culinary purposes, the inferior qualities being used for burning. It is the most important oil seed cultivated in Bombay, from 500,000 to 600,000 acres being grown annually in association with juar (sorghum), wheat, or gram. Considerable quantities of the seed are exported from India.

The plant has been grown experimentally in Nyasaland for the sake of its seeds, and a sample of these, stated to be grown from Egyptian seed, was received for examination in July 1912.

The sample consisted of small white seeds, quite similar to Indian safflower seed of commerce. The seed, as received at the Imperial Institute, contained 5·7 per cent. of moisture, and yielded 29·6 per cent. of clear yellow oil. Safflower seed generally contains 30 to 32 per cent. of oil.

The seed was submitted for valuation to a firm of oil seed crushers, who reported that the sample was in good condition, and that it closely resembled the average quality of Indian safflower seed sold on the London market, except that the percentage of moisture present was somewhat higher. The firm stated that for the last few months there had been no trade in this product, and it was therefore impossible to quote a current price, but they considered that its value to oil seed crushers would probably be about £7 10*s*. per ton, less 2½ per cent. discount, delivered ex ship London (February 1913).

The firm added that oil seeds of this kind naturally find a better market when high prices are prevailing for linseed, as has been the case during the last two or three years, though the price has now fallen to a little above the normal level.

AMOORA ROHITUKA SEEDS FROM INDIA

Amoora Rohituka, W. and A. (natural order, Meliaceæ), is an evergreen tree found in Northern and Eastern Bengal, and Assam, where it is known as "raina." The oil is used locally for medicinal purposes and for burning.

A small sample of raina seeds was received from Bengal in July 1911. It consisted of nearly round, brownish-black seeds, with narrow pale brown hilum and a thin and brittle husk, which adhered to the kernel. The average weight of a single seed was about 0·7 gram. The kernels were firm, white or pale yellow, and had a nauseous, bitter taste.

The entire seeds yielded 42·5 per cent. of a viscous, clear, yellow-brown oil, with an unpleasant smell and a bitter taste.

A larger supply of the seeds was received from Bengal in August 1912. The entire seeds contained 7·5 per cent. of moisture, and yielded 43·5 per cent. of oil similar to that obtained from the previous sample. On standing, it deposited a little crystalline solid matter.

The oils obtained from these seeds were examined with the following results:

		Sample received in 1911.	Sample received in 1912.
Specific gravity at $\frac{15·5° C.}{15·5° C.}$		0·929	0·931
Solidifying point of fatty acids		—	32·4° C.
Acid value		19·6	24·7
Saponification value		193·0	192·3
Iodine value	*per cent.*	132·5	131·7
Hehner value		—	92·4
Insoluble fatty acids	*per cent.*	—	91·0
Unsaponifiable matter	*per cent.*	—	1·4
Volatile acids, soluble		—	1·2
" " insoluble		—	0·55

A portion of the second supply was submitted to a firm of oil seed crushers, who stated that the oil extracted from them would be of fair quality for soap-making, but that its flavour and acidity would render it unsuitable for edible use. They stated that the residual cake would be useless for feeding cattle on account of its bitter taste, and that the low percentage of nitrogen which it contains would render it of very little value as manure. In these circumstances, the seed is chiefly valuable on account of the fairly high yield of oil, and the firm considered it to be worth nominally about £9 per ton in the United Kingdom (April 1913) (see also p. 564).

ERUCA SATIVA SEEDS FROM INDIA

E. sativa, Mill., is an erect herb, closely allied to the mustards (natural order, Cruciferæ). It is a native of South Europe and North Africa, and is extensively cultivated as a cold-season crop in Upper India, being the commonest of the mustard tribe cultivated in Sind. The plant is largely used in India as a green fodder, especially when grown with gram or peas, and the oil cake is much appreciated in that country for feeding cattle. It is grown in India usually as a substitute for rape, and the oil expressed from the seeds is used by the natives mainly as an illuminant and to some extent for food.

A sample of the seeds described as "taramani seeds" was received at the Imperial Institute from Bengal in July 1911. The seeds were very small, and brown or dark grey in colour; 100 seeds weighed 0·25 gram. The sample also contained some linseed.

The seeds yielded 30·8 per cent. of clear, yellow oil, with a slightly mustard-like smell and taste. The oil was examined with the following results, compared with those previously recorded:

	Present sample.	Results recorded by Crossley and Le Sueur.
Specific gravity at $\frac{15.5^\circ C.}{15.5^\circ C.}$	0·915	0·915 to 0·917
Acid value	2·4	—
Saponification value	175·7	169·0 to 174·1
Iodine value . . . *per cent.*	101·6	97·4 to 99·7

This oil could probably be used for the same purposes as rape and colza oils, and the seed has occasionally been imported into the United Kingdom as a substitute for rape seed. The latter, however, usually contains 33 to 45 per cent. of oil, so that seed yielding only 30·8 per cent. of oil, as in the present case, would not be as valuable as rape seed. The sample under report also contained an undesirable amount of linseed. A firm of oil seed crushers valued the seed at about 40*s.* per quarter of 416 lb., delivered to any European port (January 1912). The price of rape seed at that date was 49*s.* 3*d.* per quarter in London for February delivery.

Calophyllum Inophyllum Seeds and Kernels from India

This evergreen tree (natural order, Guttiferæ) occurs over a wide area in the tropics, being found in various parts of India, Ceylon, Malaya, Polynesia, Australia, and East Africa. The oil is fairly extensively used by natives in India for burning. It is said to be exported from Southern India to Burma.

A small sample of the seeds described as "panang seeds" was received from Bengal in July 1911. They were brown or brownish-black in colour, almost spherical, and about ¾ to 1 in. in diameter. The shells were thin, woody, and easily broken, and had a thick layer of brown pithy substance adhering to the inner surface. The kernels were round, whitish, and soft, and also somewhat moist, containing about 13 per cent. of moisture. The average weight of a single seed was about 4·1 grams. The kernels yielded 55·0 per cent. of viscous, green oil with a slight bitter taste. On standing the oil turned cloudy, owing to the deposition of white crystalline matter.

A large supply of panang kernels was received from Bengal in August 1912. They closely resembled the kernels extracted from the previous sample of panang seeds, but they contained 3·3 per cent. of moisture, and yielded 71·4 per cent. of oil, as compared with 55·0 per cent. for the previous sample. This difference, however, is largely explained by the drier condition of the present sample of kernels. The oil was viscous, greenish-yellow, semi-solid at the ordinary temperature, and of stiffer consistency than the oil from the previous sample, probably owing to the higher percentage of free acids present.

The results of examination of the oil from these samples were as follows:

	Sample received in 1911.	Sample received in 1912.
Specific gravity	0·950 (at 15·5° C./15·5° C.)	0·880 (at 100° C./15·5° C.)
Solidifying point of fatty acids	—	36·3° C.
Acid value	45·9	77·5
Saponification value	192·8 to 202·9	194·9
Iodine value . . . *per cent.*	97·7	93·1
Hehner value	—	94·3
Insoluble fatty acids . *per cent.*	—	92·9
Unsaponifiable matter . *per cent.*	—	1·4
Volatile acids, soluble	—	0·50
" " insoluble	—	0·45

The kernels were submitted to a firm of oil seed crushers, who stated that they would be of high commercial value on account of the large percentage of oil they contain. The oil is of excellent quality for soap-making, but would be useless for edible purposes if the acid value were as high as in the present sample. The residual cake would probably only be suitable for manurial use, for which purpose it might be worth £2 per ton, or possibly slightly more. The firm stated, however, that even on this basis the kernels, if containing as much oil as this sample, should be worth £16 per ton in the United Kingdom (April 1913).

The firm of oil seed crushers who valued this sample of panang kernels as well as the raina seeds (see p. 562), stated that in both cases they had calculated the price of the oil at its value for soap-making only, on account of the high acid value. They considered, however, that it was just possible that the fresh seeds or kernels, shipped and handled quickly, might arrive at the crushing mills in sufficiently good condition to enable oils of better quality to be obtained, in which case it would be worth while to consider the possibility of using the oils for edible purposes. If this proved feasible the values of the seeds would eventually be higher than those now indicated.

CALOPHYLLUM INOPHYLLUM KERNEL OIL FROM FIJI

A sample of oil described as "ndilo" oil, from the seed of *C. Inophyllum*, was received from Fiji in April 1913.

It consisted of a viscous oil, with an unpleasant smell.

The colour was a deep blue, probably owing to contact with some iron vessel during preparation, as iron was found to be present in the oil, and oils of *Calophyllum* sp. are known to give a blue colour with iron compounds.

It had the following constants:

Specific gravity at $\frac{15·5° C.}{15·5° C.}$	0·951
Acid value	65·5
Saponification value	197·5 (approx.)
Iodine value . . . . *per cent.*	96·2

If ndilo oil is to be exported from Fiji care will have to be taken to avoid the formation of the dark blue colour characteristic of the present sample, as such dark-coloured oil, if saleable at all, would only realise low prices. Oil extracted from *C. Inophyllum* kernels from India at the Imperial Institute was of a pale greenish-yellow tint (see p. 563).

It would probably be more practicable to export the kernels from Fiji than the oil.

MESUA FERREA SEEDS FROM INDIA

M. ferrea, L., the ironwood of Assam (natural order, Guttiferæ), is an evergreen tree found wild in the mountains of North-eastern and Southern India, Burma, the Andamans, and Ceylon, and is cultivated in various parts of India. The oil is used by the natives for burning and for medicinal purposes.

A small sample of the seeds labelled "nahar seeds" was received from Bengal in July 1911. It consisted of brown, shining seeds of irregular shape (in many cases pear-shaped), with brittle woody shells and kernels of a dark buff colour. Some of the kernels were mouldy. The average weight of a single seed was about 3·9 grams. The seeds consisted of kernel 56 per cent., shell 34 per cent. The kernels yielded 76 per cent. of oil, equivalent to a yield of about 49 per cent. from the whole seed. The oil was reddish-brown with a curious sweetish odour and a slight unpleasant taste. On standing for a few days at about 15° C. it became semi-solid.

A further supply of the seeds was received from the

Superintendent of the Central Farm, Dacca, in April 1913. It resembled the previous sample, but some of the seeds contained mouldy kernels; about 16 per cent. of those examined had been attacked by insects. The seeds consisted of approximately 61 per cent. kernel and 39 per cent. shell. The sound kernels contained 3 per cent. of moisture, and yielded 75·6 per cent. of oil, equivalent to about 46 per cent. of oil from the whole seed. The oil was dark reddish-brown, somewhat viscous, and became pasty and semi-solid when cooled. The cold oil had a slight odour, which became stronger and somewhat unpleasant on warming. It had a bitter taste.

The oil obtained from these two samples of seed was examined with the following results:

		Sample received in 1911.	Sample received in 1913.
Specific gravity		0·935 (at 15·5° C./15·5° C.)	0·932 (at 100° C./15·5° C.)
Solidifying point of fatty acids		—	30·5° C.
Acid value		20·1	16·2
Saponification value		204·0	204·9
Iodine value	*per cent.*	90·0	92·2
Hehner value		—	91·9
Insoluble fatty acids	*per cent.*	—	90·5
Unsaponifiable matter	*per cent.*	—	1·4
Volatile acids, soluble		—	6·7
" " insoluble		—	0·4

This oil resembles in its chemical characteristics the samples previously examined by Hooper in India. Its colour, smell, and taste would render it unsuitable for use as an edible oil, but it could be used for burning or lubricating, and probably for soap and candle manufacture.

The seeds were submitted to a large firm of oil seed crushers for valuation. After conducting technical trials, they reported that probably the only use for the oil would be for soap manufacture, for which purpose it might be expected to realise from £25 to £27 per ton in the United Kingdom (July 1913).

The residual cake has a bitter flavour, and in view of the fact that the kernels of *M. ferrea* are stated (see *Bull. Inst. Botan. Buitenzorg*, 1904, **21**, 4) to contain a poisonous resin acid, which is soluble in the oil and appears to act as a heart poison, the cake could not be utilised as a feeding-stuff.

Assuming, however, that the cake were valueless (its manurial value being in any case very small), the whole seeds would be worth £10 to £11 per ton in the United Kingdom, and the kernels £17 to £18 per ton.

It appears likely that the foregoing prices would render it possible to export nahar seeds in commercial quantities from India, and information has been requested as to the possibility of shipping consignments for sale in London. It would be preferable to export the kernels, and not the entire seeds, as the shells are of no commercial value, and would add considerably to the cost of transport.

Telfairia pedata Seeds from Uganda

A sample of the seeds of *T. pedata*, Hook. (natural order, Cucurbitaceæ), was received from Uganda in August 1912.

The seeds were flat, irregularly circular, about 1¼ to 1½ in. in diameter, and covered with a tough fibrous layer. They averaged 5·8 grams in weight, and consisted of fibrous husk 8·7 per cent., shell 36·6 per cent., and kernel 54·7 per cent. The kernels contained 4·6 per cent. of moisture, and yielded 62·9 per cent. of viscous, reddish-brown oil.

The seeds of *T. pedata* furnish a non-drying oil which would be suitable for soap-making. The shells, however, contain an intensely bitter substance, which finds its way into the oil when the entire seeds are crushed, so that the oil thus obtained could not be utilised for edible purposes, and the residual cake would be unsuitable for use as a feeding-stuff. An oil of better quality could be obtained by crushing the kernels alone, but so far no machine has been devised capable of removing the fibrous husk and the hard shell.

Further information regarding the commercial utilisation of these seeds will be found in an article on the subject in this Bulletin (1912, **10**, 223).

Illipe Oil from Mauritius

A sample of illipe oil derived from the kernels of *Bassia latifolia* was received from Mauritius in November 1912.

The Bassias are well-known Sapotaceous plants, the kernels of which are largely exported from India under the name of "mowra" seeds. The fats obtained from the kernels of *B. latifolia*, *B. longifolia*, and *B. butyracea* have already been investigated at the Imperial Institute (this BULLETIN, 1911, **9**, 228), the material being obtained from India and Ceylon, whilst the fat of a form of *B. Mottleyana* from British North Borneo has also been examined (this BULLETIN, 1912, **10**, 549).

The present sample from Mauritius was stated to be manufactured at Port Louis, 100 kilos of shelled nuts yielding 16·34 litres of pure oil, *i.e.* about 15 per cent.

Six bottles of the oil were forwarded, each containing a yellow fat and a quantity of liquid, yellow oil. On mixing the fat and the oil a homogeneous pasty yellow fat was obtained, which had a very faintly rancid taste.

The results of examination of the oil were as follows, compared with oil extracted at the Imperial Institute from the kernels of *B. latifolia* from India:

	Present sample.	Oil extracted from kernels of *B. latifolia* at the Imperial Institute.
Specific gravity at $\frac{100^\circ \text{C.}}{15\cdot5^\circ \text{C.}}$	0·861	0·862
Solidifying point of fatty acids	37·9° C.	43·2° C. to 46·0° C.
Acid value	20·3	—
Saponification value	196·2	188·3 to 195·3
Iodine value *per cent.*	52·6	56·7 to 61·5
Hehner value	95·3	94·2 to 96·4
Insoluble fatty acids *per cent.*	95·01	—
Unsaponifiable matter *per cent.*	0·29	2·0 to 3·5
Volatile acids, soluble	0·55	0·2 to 0·9

Samples of the fat were submitted for valuation to soap manufacturers and to makers of edible fats. One of the soap-making firms reported that the fat yielded a good, hard, yellow soap, and that for this purpose it would realise about the same price as good palm oil, the value of which then varied from £27 to £30 per ton in Liverpool (May 1913). A second firm also described the product as a good soap-making fat, though they added that it could not be used to replace high-grade tallow.

With reference to the suitability of the fat for edible use, the experts who were consulted were of opinion that it was unlikely to be of any value for this purpose.

This illipe fat from Mauritius is somewhat softer than specimens from other sources examined at the Imperial Institute, the solidifying point of the fatty acids being rather low. This may be due to the method of preparation, as it is obvious from the low yield obtained (only about 15 per cent.) that the extraction of the fat was far from complete. *B. latifolia* kernels have usually been found to contain from 45 to 55 per cent. of fat.

Unless the kernels are treated by efficient crushing machinery, so that a satisfactory yield of fat is obtained, it would be more profitable to export the dried kernels than the fat. The present value of "mowra" kernels (*Bassia* spp.) from India is about £11 per ton in the United Kingdom (June 1913), and there is a large market for this product.

PENTADESMA BUTYRACEA FRUITS AND KERNELS FROM WEST AFRICA.

P. butyracea, Don (natural order, Guttiferæ), the "butter or tallow tree" of Sierra Leone, is a fairly large tree confined to West Africa, being found from Sierra Leone southwards to beyond the equator. It is said to be very common in the southern part of the Epe, Jebu Ode, and Ondo districts of the Western Province, Southern Nigeria, as well as in the Forcados district of the Central Province. It occurs in the most humid parts of the tall evergreen forests throughout the south-west of the Gold Coast Colony, as a rule being restricted to the crests and slopes of gentle undulations, and is not found on the highest ground or in marsh land

The fat is extracted from the seeds by the natives in some parts of West Africa, and is used for cooking purposes. A sample of this fat from Sierra Leone was examined at the Imperial Institute in 1908 (see this BULLETIN, 1908, **6**, 375), and samples of the kernels from Southern Nigeria, and of the fruits and kernels from the Gold Coast, have been received recently for investigation.

Southern Nigeria

A small supply of the kernels was received from Southern Nigeria in April 1911. It consisted of large brown kernels, irregular in shape and dirty pink to brown internally. The kernels were very moist when received, and on drying in the air they lost about 34 per cent. of their original weight. The air-dried kernels averaged 12 to 13 grams each in weight, and then contained 10·6 per cent. of moisture and yielded 40 per cent. of fat. The latter was of a pale yellow colour and had a pleasant smell and taste.

The fat was examined with the following results, compared with the fat of *P. butyracea* from Sierra Leone, previously examined (*loc. cit.*):

	Present sample.	*P. butyracea* fat from Sierra Leone.
Specific gravity at $\frac{15{\cdot}5^\circ \text{C.}}{15{\cdot}5^\circ \text{C.}}$	0·857	0·859
Acid value	3·1	3·6
Saponification value	186·0	190·1
Iodine value . . . *per cent.*	46·5	41·8

A sample of the kernels was submitted to a firm who had applied to the Imperial Institute for information regarding the possibility of obtaining commercial supplies of the kernels. They reported that samples of *P. butyracea* kernels, which they had examined, showed considerable variation in the yield of fat, largely owing to imperfect drying and differences in the degree of ripeness. They also stated that the fat is highly coloured and needs refining before it can be used to advantage in soap-making, whilst the residual cake is of no value as a feeding-stuff for cattle. In view of these facts they considered that the value of *P. butyracea* kernels would probably be £8 to £10 per ton in the United Kingdom, if imported in good, dry condition.

Gold Coast

The following samples of the fruits and kernels of *P. butyracea* were received from the Gold Coast in October, 1912:

1. Fruits collected in middle of August 1912.
2. Fruits collected at end of September 1912.
3. Kernels collected in middle of August 1912.

4. Kernels collected in middle of September 1912.

5. Kernels collected at end of September 1912.

The fruits were lemon-shaped, averaging 5 to 6 in. in length, and 2½ to 3½ in. in diameter. The colour was dark brown. Each fruit contained about eight kernels, surrounded by dark-coloured pulpy matter. The proportion of kernel to husk and pulp was as follows:

Sample.	Kernel. *Per cent.*	Husk and pulp. *Per cent.*
1.	41	59
2.	37	63

The kernels as extracted from the fruits were of irregular shape, and measured about 1½ in. in length by 1 in. in diameter; they were covered with a thin brown skin, and were white internally. On drying in the air they became brittle, and shrank to a size of about ¾ by ½ in., while the interior became brown.

The three samples of kernels 3, 4, and 5, were examined with the following results:

Number of sample.	Loss on drying in the air.	The air-dried kernels contained:	
		Moisture.	Fat.
	Per cent.	*Per cent.*	*Per cent.*
3.	59	14·5	7·0
4.	74	11·3	12·6
5.	70	13·8	11·4

The fat was solid and of dark brown colour, and had a slight odour.

Previous observers have recorded 32 to 41 per cent. of fat in the kernels of *P. butyracea* (see preceding report on a sample from Southern Nigeria), and even larger amounts have been mentioned (Wehmer, *Die Pflanzenstoffe*, i. p. 497). The highest proportion of fat in the present samples is only 12·6 per cent. in the air-dried kernels, and such kernels would be useless for export to Europe.

These results are recorded as illustrating the necessity of collecting for export only the kernels from fully ripe fruits.

A further small quantity of *P. butyracea* kernels from the Gold Coast was received in February 1913.

The sample consisted principally of large irregular brownish kernels, a quantity of small shrivelled or immature seeds being also present. The material had not been thoroughly dried, the kernels containing 37·7 per cent. of moisture and only 22·6 per cent. of fat. If thoroughly dried in the sun the kernels would have contained about 10 per cent. of moisture and 31 per cent. of fat. The fat was similar to that extracted from the previous samples.

General Remarks

The results of examination of these *P. butyracea* kernels from the Gold Coast confirm the manufacturer's statement quoted above (p. 570), that the kernels are variable in quality. For export it is desirable that only mature kernels should be collected and that they should be thoroughly dried in the sun before being shipped.

Gru-Gru Nuts and Kernels from the West Indies.

The gru-gru palm, *Acrocomia sclerocarpa*, is native to the West Indies and to South America from Brazil southwards, and is said to form vast forests in Paraguay. The kernels yield an oil also known as "mocaya" oil, and they have been imported into this country from time to time from South America.

Some interest is being taken in these kernels at the present time, and inquiries have been made by the Imperial Institute with a view to ascertaining whether the palm occurs in sufficient abundance in the West Indies to enable the kernels to be exported on a commercial scale. The results of the inquiries showed that the kernels are scarce in Jamaica and there does not appear any possibility of an export trade from that Colony. The palm is widely distributed in Trinidad, but does not commonly occur in such abundance as would render any considerable export trade easy of development; moreover the kernels are in local demand, being roasted and eaten. In Grenada the palm grows freely on poor, rocky hill soils, and might provide material for export without interfering with other crops. The palm exists in some numbers in St. Vincent, but the plants are being destroyed to make way for cotton cultivation, while it occurs in smaller numbers in St. Lucia and in the Leeward Islands. In connection with this inquiry gru-gru nuts from Grenada and kernels from Trinidad were forwarded to the Imperial Institute for examination.

No. 1. Gru-gru Nuts from Grenada.—These were rounded, brown nuts, slightly flattened at the base and bluntly pointed at the apex. The length from apex to base was ¾ to 1 in., and the diameter was 1 to 1⅛ in. Each nut possessed three "eyes," situated about halfway between the apex and the base.

The shells of the nuts were hard, brittle, and woody; they measured slightly over ⅛ in. in thickness. The kernels, which were of irregular shape, were dark brown externally and white within, and were somewhat similar in appearance to ordinary oil palm kernels (*Elæis guineensis*).

The kernels, which were found to contain 7·3 per cent. of moisture, yielded 56·2 per cent. of a white crystalline fat. This product resembled coconut oil, but it was more opaque and had a less marked odour; it also resembled palm kernel oil.

No. 2. Gru-gru Kernels from Trinidad.—This sample consisted of small, roughly spherical kernels, about ½ to ¾ in. in diameter, with a wrinkled, dark brown exterior. The kernels were in good condition.

They contained 6·1 per cent. of moisture and yielded 57·0 per cent. of a yellowish-white, solid, crystalline fat, similar to that obtained from the kernels from Grenada.

The fats obtained from these two samples were examined with the following results, compared with the corresponding figures for palm kernel oil:

	No. 1.	No. 2.	Palm kernel oil
Specific gravity at $\frac{100^\circ \text{C.}}{15{\cdot}5^\circ \text{C.}}$	0·868	0·867	0·8731
Acid value	1·5	1·3	—
Saponification value	255·1	253·7	242·4 to 254·8
Iodine value . . . *per cent.*	21·0	16·2	10·3 to 17·5
Titer test	20·5° C.	—	20° to 25·5° C.
Hehner value	89·5	88·5	91·1
Insoluble fatty acids, *per cent.*	89·04	88·1	—
Unsaponifiable matter, *per cent.*	0·46	0·4	—
Volatile acids, soluble	6·8	5·7	5·0 to 6·8
" " insoluble	10·0	12·6	—

Commercial Value

The present value of oil palm kernels in the United Kingdom is from £23 5*s*. to £24 per ton, ex quay Liverpool (September 1913), and gru-gru kernels should fetch about the same price, since they are as rich in fat as palm kernels. The gru-gru kernel oil is, however, a little softer than palm kernel oil, and this may make a slight difference in the price obtainable for the kernels. This point, however, can only be determined after consignments have been marketed and manufacturers have been able to try the oil on an industrial scale in comparison with coconut and palm kernel oils.

Experiments conducted at the Imperial Institute have shown that gru-gru nuts can be shelled fairly satisfactorily by means of the nut-cracking machine made by Messrs. Miller Brothers, of Liverpool, which is referred to in this BULLETIN (1909, **7**, 386). In a trial made with gru-gru nuts 68 per cent. were completely shelled on passing once through the machine, and 8 per cent. were partly shelled. The latter, with the remaining 24 per cent. of undecorticated nuts, were passed through the machine a second time, after which only 2 per cent. remained undecorticated and 3 per cent. partly shelled. The nuts behaved very similarly to oil palm nuts during shelling. Better results would probably be obtained after ascertaining by experiment the correct speed at which the machine should be run for shelling gru-gru nuts, but the quantity of nuts available was too small to permit of this being done in this case.

Remarks

As already indicated, there is no doubt that gru-gru kernels in good condition would find a ready market in the United Kingdom at prices approximating to those of palm kernels, if they can be offered in commercial quantities, *i.e.* in shipments of from 50 to 100 tons at a time.

GROUND NUTS

THE increasing use of ground-nut oil for edible purposes has stimulated the cultivation of the plant in most countries where the climatic and other conditions are favourable to its growth. At the present time most of the ground nuts imported into Europe come from India, China, Gambia, and Senegal. They are also being grown fairly extensively for export in Northern Nigeria, Uganda, and Nyasaland, whilst they are being grown on a smaller scale or experimentally in other parts of Africa, in the West Indies, Fiji, etc.

Ground nuts from several of the countries mentioned above have been received at the Imperial Institute, and a sample from Fiji has been described already in this BULLETIN (1909, **7**, 272). Ground-nut oils prepared locally in Southern Rhodesia, Northern Nigeria, Mauritius, and Hong Kong have also been examined (this BULLETIN, 1906, **4**, 97; 1908, **6**, 356; 1910, **8**, 5; 1912, **10**, 229). In the following pages ground nuts from Northern Nigeria, Gambia, Fiji, and Montserrat, and ground-nut oil from Fiji, are described. An account of the cultivation and utilisation of the ground nut is given in this BULLETIN (1910, **8**, 153).

NORTHERN NIGERIA

Until quite recently most of the ground nuts exported from Northern Nigeria have been produced in the vicinity of Bida, in the Niger Province, but since the opening of the railway to Kano the output from this district has increased enormously. Complete statistics of exports from Northern Nigeria are not obtainable, but the following are the quantities and values of ground nuts exported *via* the Idah Customs Station, across the Southern Nigeria boundary, in recent years.

	Tons.	£
1907	1,811	14,413
1908	2,104	13,658
1909	1,733	16,374
1910	908	8,171
1911	875	7,898
1912	1,715	14,536

In addition 142 tons, valued at £1,126, were exported *via* the Lagos Government Railway from February 1 to December 31, 1911, and 202 tons, valued at £1,327, in 1912.

Mr. P. H. Lamb, the Director of Agriculture, Northern Nigeria, states that what strikes the agriculturist most forcibly, on visiting the sandy plains of Bida or Kano for the first time, is the ideal soil which exists in both these localities for ground-nut production, the heavy yields obtained, and the high quality of the crop (*Nigerian Customs and Trade Gazette*, June 2, 1913). A yield of over 1 ton of freshly harvested nuts per acre was being generally obtained at Kano and at Bida in the 1912–13 season, *i.e.* at least 1,400 lb. of kernels per acre. By selling the latter at ⅝*d.* per lb., a common price at Kano, a return of £3 12*s.* 11*d.* per acre is obtained, which is said to be quite acceptable to the native producer. The cash price offered for the kernels at Badegi, 43 miles from Baro, in the Niger Province, is £6 per ton, *i.e.* only about the same as the price at Kano, although the kernels have to be carried about 365 miles on the railway from the latter place. If the price paid in the Niger Province could be raised somewhat, it is thought there would be no question that the production would increase greatly. The establishment of a buying depôt at Wuya Kede would be a distinct advantage, as this village is an important ferry situated on the Kaduna river, 35 miles from its confluence with the Niger river, in the centre of a rich and populous district. Large numbers of canoes are available here, and transport can be arranged to Lokoja for as little as 30*s.* per ton.

Another factor tending to check ground-nut production in the Niger and Ilorin Provinces, apart from the inadequate price, is the refusal of trading firms to buy the unshelled nuts. The manual labour involved in shelling a ton of nuts is enormous, as one woman can deal with only about 7 lb. of unshelled nuts per hour. The difficulty could be overcome by the installation of decorticating machines somewhere on the river, say at Egga; but the Director of Agriculture considers that in view of the very much lower price which the native is willing to accept for the unshelled nut the shipping of the nuts in this form is well worthy of attention.

A superior variety of ground nut is grown in limited quantity in the neighbourhood of Pategi, Ilorin Province, and a quantity of this was received for examination at the Imperial Institute in December 1912.

The sample consisted of large, unbroken ground nuts of good appearance. The majority of the nuts were about 1¾ in. long and ⅝ in. in diameter, but a few medium-sized nuts were present, and also some which were 2¼ in. in length. Each nut contained two kernels in good condition. The sample was free from extraneous matter.

The nuts were submitted for valuation to a firm of brokers, who reported that they were much larger and of better quality than the Nigerian ground nuts usually marketed in Liverpool, and valued them at about £19 per ton (March 1913), adding that good prices were then ruling for ground nuts in the United Kingdom.

GAMBIA

As already mentioned, large quantities of ground nuts are produced in Gambia, the exports during 1912 being 64,169 tons, valued at £502,069. Three samples of ground nuts have been received for examination from this Colony, the first two in February 1910, and the third in January 1911.

No. 1.—"Ordinary Gambia ground nut, Sika." These were somewhat elongated nuts in good condition, consisting of kernel 66 per cent., and shell (husk) 34 per cent. Most of the nuts contained two kernels each, and about 13 per cent. contained three. The kernels yielded 50 per cent. and the whole nuts 33 per cent. of pale yellow, liquid oil.

No. 2.—"Light-skinned ground nuts, Bantankilling. From three or four seeds received from Senegal." The nuts in this sample consisted of kernel 80 per cent., and shell (husk) 20 per cent. They were rounder than the ordinary variety of ground nut. Most of them contained two kernels each, but none were found with three, and about 16 per cent. had only one kernel. A few somewhat mouldy kernels were present in the sample. The kernels had dirty-white or buff-coloured skins. The kernels contained 49·5 per cent., and the whole nuts 39·6 per cent. of pale yellow, liquid oil.

The following table shows the results of chemical examination of oil extracted from these two varieties of ground nuts :

	Oil from nuts of sample 1.	Oil from nuts of sample 2.	Commercial ground-nut oil.
Specific gravity at $\frac{15·5° C.}{15·5° C.}$ . .	0·928	0·928	0·9195–0·9256
Saponification value . . .	191	190	185·6–197
Iodine value . . *per cent.*	89	85	83·3–105

From the results of these examinations it appears that the Bantankilling ground nuts furnish a larger proportion of kernels than the ordinary Gambia variety, and therefore give a somewhat larger percentage of oil calculated on the whole nuts. This difference is, however, probably not sufficient to give the Bantankilling variety any considerable advantage over the ordinary kind from a commercial point of view, unless this variety gives a larger yield of nuts, or offers any advantage in cultivation.

No. 3.—These were described as "Fiji ground nuts grown at Kotu, in Gambia." The nuts were large, each containing two kernels. They consisted of kernel 73 per cent., and husk 27 per cent.

The kernels yielded 48·2 per cent. of oil, whilst those of a sample from Fiji previously examined contained 49·1 per cent. (see this BULLETIN 1909, **7**, 272). The oil had the usual appearance of ground-nut oil, and was not submitted to chemical examination.

The sample was too small for valuation, but ground nuts of similar quality would, when decorticated, probably realise the normal price of good ground-nut kernels, which was then £14 10*s*. to £15 10*s*. per ton in London (March 1911).

There is a demand for unshelled ground nuts of this description, but it is somewhat uncertain, and the price shows considerable fluctuation.

MONTSERRAT

The ground nut is being cultivated experimentally in most of the botanic stations in the West Indies, and eight samples from Montserrat, representing the material produced in the 1911 experiments, were received for examination in January 1912. The yields of dried nuts per acre obtained in the experiments carried out in 1910 and 1911 were as follows:

Variety.	1910. lb.	1911. lb.
Carolina Running	1,706	2,438
Carolina Running (small-seeded) . .	1,548	—
Gambia	1,479	2,041
Gambia (three-seeded)	1,254	2,027
Local Variety	1,670	1,789
Red Tennessee	765	1,846
Virginia Running	—	1,836

The seeds sown in 1911 in the case of the two types of Carolina Running, the two varieties of Gambia, and the Red Tennessee, were the second generation from specially selected plants. The 1911 season was not specially favourable for the crop, as there was a comparative drought during August and September, and its effect on some of the varieties was easily observable; but the Gambia types suffered least.

The results of the experiments showed that although the Carolina Running variety gave the highest yield, the quality of the nuts leaves something to be desired, and the Gambia variety is considered to be the most satisfactory type so far tried in Montserrat.

The samples examined at the Imperial Institute were as follows:

No. 1. "Local."—Rather small nuts, with dirty-looking husks and small kernels with reddish-brown skins. Many of the kernels were shrivelled.

No. 2. "Gambia (three-seeded)." — Fair-sized nuts, which had in most cases clean husks of good colour. The kernels were mostly plump and clean, with pinkish skins; a few, however, were shrivelled. Twenty-two per cent. of the nuts contained three kernels each.

No. 3. "Gambia."—These nuts resembled the preceding variety, but the kernels were darker, and a larger number were shrivelled; none of them contained more than two kernels.

No. 4. "Spanish."—Small nuts of dirty appearance, with very small rounded kernels, which had pale pinkish-brown skins. A good many kernels were shrivelled.

No. 5. "Carolina Running."—Large, rather long nuts, of dirty colour and containing very large kernels, mostly with reddish-brown skins. Some kernels had skins of a dirty brown colour, and a few were shrivelled.

No. 6. "Carolina Running (small-seeded)."—Fair-sized nuts of rather dirty colour, with kernels of medium size, having skins varying in tint from reddish-brown to dirty brown. A few kernels were shrivelled.

No. 7. "Virginia Running."—Large nuts of good appearance, in most cases having clean-looking husks and somewhat long, plump kernels with rather dark red skins. Some shrivelled kernels were present.

No. 8. "Red Tennessee."—Very long, large nuts, of fairly good appearance, with very dark reddish-brown kernels of fair size; a considerable number of the kernels were shrivelled. Nearly half the nuts contained three kernels. The kernels had a rather unpleasant taste.

The following table shows the average weight of the single nuts in each sample, the percentage of husk and kernel, and the percentage of nuts containing one, two, three, or no kernels:

Sample No.	1.	2.	3.	4.	5.	6.	7.	8.
Average weight of a single nut . . *grams*	0·87	1·20	1·14	0·65	1·62	1·36	1·97	1·96
Percentage of husk . .	30	30	33	24	30	26	30	36
Percentage of kernel .	70	70	67	76	70	74	70	64
Percentage of nuts containing:								
1 kernel . . .	13	10	16	35	22	17	9	20
2 kernels . . .	83	60	84	61	76	80	91	29
3 kernels . . .	*nil*	22	*nil*	*nil*	*nil*	*nil*	*nil*	49
No kernel . . .	4	8	*nil*	4	2	3	*nil*	2

The nuts were submitted for valuation to (1) a firm of brokers in Liverpool, (2) a firm of oil seed crushers in Marseilles, and (3) a firm of merchants in Hamburg. The three firms reported on the samples as follows:

(1) The samples are all of inferior colour, and of a quality rarely marketed in Liverpool. They are not fine enough for sale to English fruit merchants or confectioners, and would be more likely to find a market among Continental oil seed crushers. Their values in Liverpool, ex

quay, in bags, would probably be approximately as follows (May 1912):

No.	Name.	Price per cwt.
1	Local	10*s.*
2	Gambia (three-seeded)	10*s.*
3	Gambia	12*s.*
4	Spanish	9*s.*
5	Carolina Running	11*s.*
6	Carolina Running (small-seeded)	10*s.*
7	Virginia Running	12*s.* 6*d.*
8	Red Tennessee	12*s.*

(2) These ground nuts should realise in Marseilles prices similar to those obtained for "Gambia" nuts, the current value of which is 35 fr. per 100 kilos (14*s.* 2*d.* per cwt.) c.i.f. Marseilles (April 1912).

(3) The value of the samples for edible purposes, c.i.f. European ports, should be as follows, with Rufisque ground nuts at 36 fr. per 100 kilos (14*s.* 7*d.* per cwt.):

Nos. 1, 2, 3, and 6.	About 34 fr. per 100 kilos.	13*s.* 10*d.* per cwt.
No. 4	" 32 " " "	13*s.* "
Nos. 5, 7, and 8	" 30 " " "	12*s.* 2*d.* "

It may be pointed out in connection with these valuations that the current price of undecorticated Coromandel ground nuts in the United Kingdom at the time of the report was 13*s.* to 14*s.* per cwt. (May 1912). Rufisque ground nuts suitable for edible use are more valuable, and good samples are worth about 17*s.* per cwt. (April 1912).

It is clear from the foregoing results that these ground nuts would be saleable in Europe. The large supplies of ground nuts imported to the Continent are mainly used for the preparation of edible oil, whilst the small quantities of unshelled nuts imported to the United Kingdom are used as edible nuts. For the latter purpose it is desirable that the husks should be clean and of good colour, and special attention would have to be given to these points where it is proposed to export ground nuts to the United Kingdom.

FIJI

Ground nuts are only cultivated on a very small scale in Fiji at present, the export in 1911 being 3 tons 7 cwts., valued at about £51.

The sample referred to below was received for examination in July 1909. It was labelled "Spanish Pea Nuts," and consisted of unshelled nuts, described as representing the 1909 crop grown at the experimental station at Lautoka.

The nuts were mostly in very good condition, but a few were slightly damaged or discoloured. They were large, varying in length from 1¼ to 2 in., with an average of about 1⅜ in. Most of the nuts contained two kernels, but there were a few containing only one. The kernels extracted from the nuts were in good condition, very few being shrivelled or discoloured. They were of normal size, colour, and appearance, and formed about 70 per cent. by weight of the unshelled nuts.

The sample of Fiji ground nuts previously examined at the Imperial Institute was found to give an average yield of oil, and as the present sample was quite similar no further analysis was made.

The best market for ground nuts is Marseilles, and for that reason samples of these Fiji nuts, previously shelled, were submitted to a firm in that port for valuation. They reported that the kernels would sell in Marseilles at about the same rate as Coromandel kernels, viz. 30 fr. per 100 kilos (about £12 per ton) in December 1909.

Samples of the shelled nuts were also supplied to brokers in Liverpool, who stated that they would be worth about as much as Chinese kernels, viz. £13 10*s.* to £14 per ton, c.i.f. (December 1909).

Ground-nut Oil from Fiji

A sample of ground-nut oil stated to have been expressed from large Spanish ground nuts in the cold, was received in April 1913. It consisted of golden yellow oil, faintly opalescent, but otherwise of the usual appearance of ground-nut oil.

The constants of the oil were as follows:

Specific gravity at $\frac{15\cdot5^\circ \text{C.}}{15\cdot5^\circ \text{C.}}$		0·919
Acid value		2·4
Saponification value		193·2
Iodine value	*per cent.*	89·4

This oil is evidently of good quality, the acid value being comparatively low, and it would probably be worth about £30 a ton in the United Kingdom. If better prepared, however, of a paler tint, and cleared so as to remove the opalescent appearance, it should realise £37 or more per ton as an edible oil (September 1913).

BAOBAB FRUITS AND SEEDS FROM THE EAST AFRICA PROTECTORATE

The baobab tree (*Adansonia digitata*, L., natural order, Malvaceæ) is a large tree common in many parts of Africa and growing also in India and other tropical countries. The inner bark is very fibrous and is used by the natives of West Africa for the manufacture of rope and sacking, and it was at one time imported to this country for paper-making. A sample of the bark from Rhodesia, and one of fibre prepared from the bark in the East Africa Protectorate, have been examined at the Imperial Institute (this BULLETIN, 1904, **2**, 169; 1907, **5**, 234). The leaves and the acid pulp which surrounds the seeds are used in native medicine in West Africa, and the results of examination of specimens of these two products from Sierra Leone, stated to be derived from *A. digitata*, have been described in this BULLETIN (1906, **4**, 252).

The seeds of some species of Adansonia, *e.g. A. madagascariensis*, Baill., and *A. Grandidieri*, Baill., contain a considerable quantity of oil and have appeared on the oil seed market in Marseilles. In order to ascertain whether the baobab seeds of East Africa were likely to be of commercial value in this direction, a supply of the seeds and fruits was obtained from the East Africa Protectorate for examination at the Imperial Institute. The Director of Agriculture stated that it is estimated that there are approximately 30,000 baobab trees in the Protectorate, each of which yields annually on an average 30 lb. of dry seed, in all over 400 tons per annum. The acid pulp surrounding the seeds, after being soaked in water and with the addition of a little common salt or sea-water, yields an extract which forms the chief agent used in East Africa for coagulating the latex of the Ceara rubber tree, and it is thought that a considerable quantity of seed would be available as a by-product at the rubber plantations.

The results of examination of the seeds and fruits have been communicated to the Society of Chemical Industry in a paper by Mr. R. G. Pelly, F.I.C., of the Scientific and Technical Department of the Imperial Institute (*Journ. Soc. Chem. Indust.* 1913, **32**, 778). These results may be summarised as follows:

Each fruit weighed about 1 lb., and consisted of a hard, brittle, woody shell, about 11 in. long and 4 in. in diameter, and bluntly pointed at the ends. The interior was divided into nine compartments by fibrous septa; each compartment contained a mass of dry buff-coloured friable pulp surrounding and adhering to the numerous small kidney-shaped seeds. The fruits were composed of outer shell 41–48 per cent., pulp 14–17 per cent., seeds 36–42 per cent.

The outer woody shell yielded 2·4 per cent. of ash, containing: silica, 2·8 per cent.; potash, 47·0 per cent.; soda, 1·5 per cent.; phosphoric anhydride, 0·3 per cent.

The seeds were composed of a very tough husk enclosing a soft oily kernel, devoid of starch. They were examined with the following results:[1]

	Per cent.
Moisture	12·1
Ash	3·5
Oil	11·6
Proteins	11·2
Fibre	22·5
Carbohydrates (*by difference*)	39·1

The ash of the seeds contained: potash, 31·0 per cent.; soda, 7·2 per cent.; phosphoric anhydride, 34·2 per cent.

The oil as extracted by light petroleum was viscous, clear, and bright yellow, with no marked taste or odour; it gave the following results, to which are added, for purposes of comparison, the results obtained by previous observers for oil from seeds of *A. digitata* and fat from seeds of *A. Grandidieri*.

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[1] Owing to the tough nature of the husk it was extremely difficult to grind the seeds and mix the material thoroughly; the analytical results are, therefore, only approximately accurate.

	Oil from baobab seeds from East Africa.	Oil from seeds of *A. digitata*.	Fat from seeds of *A. Grandidieri*.
Yield of oil . *per cent.*	11·6	12·5	42·6
Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$.	0·920	0·915	0·918
Saponification value . .	193·5	190·5-191·7	189·9-190·9
Iodine value . *per cent.*	82·0	76·7- 77·8	53·9- 56·8

From the above figures it is obvious that the British East African seeds contain too small an amount of oil to render them of commercial value as a source of oil.

The seeds are free from alkaloids and cyanogenetic glucosides, but the husks are so tough that the seeds would require boiling to soften them before they could be employed as cattle food. The seeds, or the ash from them, which is rich in potash and phosphates, could be used as manure.

Fruit Pulp.—Specimens of the fruit pulp of species of *Adansonia* have been investigated previously. Slocum (*Pharm. Journ.* 1879–80, **10**, series 3, 816) stated that the pulp of *Adansonia* sp. (probably *A. digitata*) contained pectin, glucose, malic acid, and acid potassium malate, etc.; Heckel and Schlagdenhauffen (*Pharm. Journ.* 1888-89, **19**, series 3, 246) recorded the presence of tartaric acid (2 per cent.) and potassium hydrogen tartrate (12 per cent.), etc.; Millard (*Pharm. Journ.* 1889-90, **20**, series 3, 829) stated that traces of tartaric acid and 10 per cent. of potassium hydrogen malate were present in the pulp of a species of *Adansonia*, probably *A. madagascariensis*. The pulp of *A. digitata* from Sierra Leone previously examined at the Imperial Institute (this BULLETIN, 1906, **4**, 252) was found to contain free tartaric acid and potassium acid tartrate, as well as a large quantity of mucilaginous matter.

In the case of the present sample from the East Africa Protectorate specimens of pulp taken from different fruits yielded the following results:

	Per cent.
Moisture	15–16
Ash	4·76– 6·10
Matter soluble in alcohol . . .	16·7 –18·7

The ash consisted largely of alkaline carbonates and contained: silica, 4·74 per cent.; lime, 8·88 per cent.; potash, 48·90 per cent.; soda, 4·20 per cent.; phosphoric anhydride, 1·08 per cent.

The greater part of the pulp was soluble in water, yielding a mucilaginous liquid and an insoluble residue of cellular tissue. The aqueous extract possessed an acid taste and reaction. The pulp consisted largely of pectous matter, and considerable difficulty was experienced in separating the crystalline acids from this matter. The method finally adopted is described in full in Mr. Pelly's paper. It was found that the acidity of the pulp is due partly to free citric acid, with possibly a small amount of malic acid, but chiefly to an acid or acids of the pectic type, possibly present as acid potassium salts. The amount of citric acid in the pulp was not more than 4·4 per cent. No indications of the presence of tartaric acid were obtained, and it was proved that such acids as tartaric, malic, or citric acids are not present as acid salts in the fruit pulp.

Commercial Value of the Seeds and Fruits

The seeds would not realise a sufficiently high price in Europe as an oil seed to make their exportation remunerative, but they might be used locally in East Africa as a cattle food, if it is feasible to soften the husks by boiling the seeds in water. The finely-ground seeds, or the ash from them, which is rich in potash and phosphates, could be employed locally as a manure.

The shell of the fruit might be used locally as fuel, and the ash of the shell employed as a potash manure.

Although the fruit pulp contains a fair amount of free citric acid, this could not be extracted remuneratively, owing to the large amount of pectous matter present, which renders the extraction of the citric acid extremely difficult. It is highly improbable that the pulp would be of any commercial value, except locally in East Africa as a rubber coagulant, or for the preparation of pleasantly acid drinks, for which purpose it is already largely used in the tropics.

TOBACCOS FROM THE EAST AFRICA PROTECTORATE

Considerable attention has been devoted in recent years to the cultivation of tobacco in various parts of British Africa, and at the present time the crop is being grown successfully in Nyasaland, Rhodesia, Transvaal, and Cape Province (see this Bulletin, 1906, **4**, 384; 1909, **7**, 27; 1911, **9**, 384, 416; 1913, **11**, 320). Among African tobaccos which have been described already in this Bulletin may be mentioned those from Nyasaland (1904, **2**, 80; 1909, **7**, 266), Transvaal (1909, **7**, 404), Cape Province (1913, **11**, 320), and Portuguese East Africa (1913, **11**, 11).

Although a coarse type of tobacco has been grown by the natives of the East Africa Protectorate for their own use for many years, it is only within the last few years that attempts have been made to grow leaf suitable for export to Europe. A number of planters have taken up its cultivation experimentally, and trials have also been made at the Government Experimental Farms at Mazeras and Kibos, but the earlier work was handicapped to a certain extent by the lack of expert advice. In 1911, however, an Adviser for Tobacco was appointed by the Government, and experiments have been commenced under his supervision at the Kabete Experimental Farm (see p. 593). A small supply of seed of American and Turkish tobaccos was obtained, and the greater part of this seed was distributed to over thirty planters, who expressed a desire to experiment with the crop, but the results of these trials are not yet available. Arrangements were made for sets of flue-pipes for tobacco-curing barns to be distributed among those planters who contemplated growing "bright American" tobaccos, one set being supplied to a planter in each of the following districts: Kikuyu, Fort Hall, Nakuro, Njoro, Lumbwa, and Uasin Gishu.

In a report furnished to the Imperial Institute the Adviser for Tobacco states that the Kibwezi district, where an extensive irrigation scheme is being introduced, will probably prove one of the most suitable in the Protectorate for the crop. Other districts which apparently have soils suited to "bright" tobacco are in the Mua Hills, near the Lower Molo river, and near part of the Sergoit river on the Uasin Gishu plateau.

Soils from Kibwezi have been examined by the Government Analyst, with the following results:

No. 1. Top soil.
No. 2. Soil taken out of a 2 ft. pit.
No. 3. Ditto.
No. 4. Top soil.
No. 5. Soil taken out of a 2 ft. pit.

Results of Chemical Analyses

No.	Moisture.	Organic matter.	Nitrogen.	Chalk.	Available phosphoric acid.	Available potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	2·50	9·53	0·238	0·028	0·0412	0·0805
2	4·05	8·37	0·109	0·004	0·0164	0·0471
3	3·49	9·79	0·092	0·008	0·0079	0·0483
4	2·43	9·96	0·227	0·070	0·0330	0·0331
5	4·07	9·69	0·081	0·009	0·0235	0·0408

Results of Mechanical Analyses

	No. 1.	No. 4.
	Per cent.	*Per cent.*
Fine gravel	*nil*	*nil*
Coarse sand	31·8	24·3
Fine sand	33·7	34·9
Silt	5·0	7·6
Fine silt	12·9	16·3
Clay	4·5	4·5
Moisture	2·50	2·43
Organic matter	9·53	9·96
Chalk	0·03	0·07

The following results of chemical analyses of soils from Kabete are quoted by the Adviser for Tobacco in his report:

No. 1. Top soil, 9 in.
No. 2. Subsoil, 9 "
No. 3. Top soil, 9 "
No. 4. Subsoil, 9 in.
No. 5. Top soil, 9 "
No. 6. Subsoil, 9 "

No.	Moisture.	Organic matter.	Nitrogen.	Chalk.	Available phosphoric acid.	Available potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	7·42	18·69	0·459	0·082	0·021	0·039
2	7·23	15·68	0·269	0·088	0·041	0·030
3	7·51	16·40	0·330	0·081	0·028	0·027
4	7·69	14·75	0·271	0·054	0·064	0·015
5	7·41	18·49	0·454	0·092	0·0382	0·011
6	7·48	14·62	0·258	0·054	0·0382	0·015

A number of soils from the East Africa Protectorate have also been examined at the Imperial Institute, and the results of examination of some of these are given in this BULLETIN (1907, **5**, 243; 1912, **10**, 405).

Experiments with several varieties of American and Turkish tobaccos were conducted at Kabete during 1912, and samples of the tobacco produced were forwarded to the Imperial Institute for examination. Tobaccos grown on private estates in earlier years have also been received. The results of the investigation of these tobaccos are given in the following pages.

First Series

The samples of tobacco which are the subject of this report were forwarded to the Imperial Institute in August 1909. They were stated to have been grown at Nairobi.

No. 1.—This consisted of three hands of "Virginian" tobacco of light "mahogany" colour, nearly free from spots and blemishes. The leaves measured, on the average, 16 in. by 8½ in.

The tobacco burnt well, leaving a pale grey ash edged with black. The aroma of the smoke was pleasant, but slightly pungent.

No. 2.—This was a small hand of light "mahogany" tobacco, in good condition. The average size of the leaves was 11 in. by 5 in., with a few larger leaves measuring 13 in. by 6½ in.

The tobacco held fire fairly well, and left a pale grey ash edged with dark grey.

No. 3.—This consisted of two hands of "Virginian" tobacco, light "mahogany" in colour, and of good appearance. The leaves varied in size from 14½ in. by 7½ in. to 17 in. by 8¾ in.

The tobacco burnt fairly well, leaving a dark grey ash. The aroma of the smoke was fairly pleasant.

No. 4.—This was a single hand of "mahogany"-coloured leaves which were in good condition, although a few showed green, unfermented spots close to the edges and midribs. The average size of the leaves was 14 in. by 8½ in.

The tobacco held fire fairly well, but unevenly, some patches burning rapidly, others merely charring. The ash was dark and carbonaceous.

No. 5.—A single hand of rather small leaves. The colour was light "mahogany," and the general appearance was good. The leaves measured on the average 10½ in. by 5½ in., while a few were 13 in. by 7 in.

The sample held fire moderately well, but unevenly, and left a very dark ash. The aroma of the smoke was rather pungent.

Samples Nos. 1 and 3 were analysed with the following results:

		No. 1. *Per cent.*	No. 3. *Per cent.*
Moisture		11·37	13·64
Total alkaloids (nicotine, etc.)		3·20	3·82
Total nitrogen		1·99	1·82
Ash		15·46	13·68
The ash contained:			
Lime	CaO	41·9	36·3
Magnesia	MgO	11·7	12·1
Potash	K_2O	21·6	19·1
Sulphuric anhydride	SO_3	3·7	3·7
Chlorine	Cl	0·4	1·3

The samples were of fairly satisfactory composition, but the ash contained somewhat high percentages of magnesia and sulphuric anhydride for the amount of potash present. More chlorine was present in the ash of No. 3 than in No. 1, and the percentage of potash was slightly lower in this sample, and these differences will account for the slightly darker colour of the ash (see p. 589).

Samples 1, 3, 4, and 5 were submitted to commercial experts, who reported that Nos. 1 and 3 were of nice appearance and burnt freely, but were not pleasant to smoke, whilst Nos. 4 and 5 lacked body and quality.

It was stated that the only real test of value would be to place the tobacco on the market, but it was considered that tobacco similar to the samples might be saleable at 3½*d.* per lb. or more (duty-free), for blending with other tobaccos requiring colour without strength.

These five samples of tobacco were of promising quality. The best is No. 1, which corresponds most closely to "Virginian" tobacco as imported to this country from the

United States, but there is on the whole little to choose between the samples except as regards the size and texture of the leaves.

The chief defects of these tobaccos, and the methods by which they can be minimised, may be summarised as follows:

(1) Some of the samples produced a smoke of slightly pungent flavour, and most of them left a dark-coloured ash.

Both these defects are probably due to the presence of too high a proportion of chlorides and sulphates compared with the potash in the ash. In manuring soil on which tobacco is grown, manures containing sulphates or chlorides should be avoided. The best manures are usually plant ashes rich in potassium carbonate, and they should be applied to the ground some months before the seedlings are planted out.

(2) Some of these samples, notably Nos. 4 and 5, consisted of small leaves, and all except No. 1 were composed of leaves which were too thin.

These defects are probably caused by the plants being grown too close together, or in poor soil. For this type of tobacco the plants should be placed at a distance of about 3 ft. from each other, and in rows 3½ ft. apart. The actual space allowed must, however, in all cases depend to some extent on the richness of the soil.

It is probable that in the present instance the soil in which the tobacco was grown would give a better product if it were green-manured.

(3) The size of the leaves included in some of the hands of tobacco varied considerably. This is an important matter in grading tobacco for export. The hands should consist of leaves not only of the same colour, but also of approximately the same size, and all hands containing leaves of a certain size should be kept together.

(4) The tobacco of the present samples was all of the "mahogany" type, that is, it was yellow, evenly marked with reddish-brown patches. It should, however, be borne in mind that the best prices are paid for "bright" and "semi-bright" Virginian tobacco, that is, for kinds which are of

uniform bright yellow or semi-bright yellow colour. Thus, at the date of the report, "ordinary" to "fine" "bright" tobaccos of this class were worth 6*d.* to 1*s.* per lb., whereas "ordinary" to "fine" "dark" tobaccos fetched from 6½*d.* to 8*d.* per lb. (December 1909).

Second Series

The following three samples of tobacco were grown at Njoro, and were received in August 1911:

No. 1.—Described as "grown from seed received from the Transvaal, and sun-dried on the stem."

This consisted of rather coarse leaves, varying from 12 to 20 in. in length, and from 5 to 8 in. in width. The colour was not uniform throughout the sample, and was patchy; the majority of the leaves were dull brownish-yellow, and the others of a lighter and brighter tint, except a few leaves which were marked with greenish patches.

No. 2.—"American tobacco dried in the shade."

This sample consisted of rather coarse leaves, of uniform shape and measuring from 16½ by 5½ in. to 20½ by 7½ in., being mostly of the larger sizes. The colour varied from dull "mahogany" to a lighter tint with a tinge of green. The leaves were slightly mouldy.

No. 3.—"American tobacco dried in the sun."

This consisted of rather coarse leaves varying in size from 13 by 4 in. to 20 by 7 in., but mostly of medium dimensions. The colour varied from bright to dull "mahogany," and a fair number of leaves had a distinct greenish tinge.

Sample No. 1 burnt fairly well and left a greyish ash. It gave the following results on analysis:

		Per cent.
Moisture		12·33
Total alkaloids (nicotine, etc.)		3·07
Total nitrogen		3·31
Ash		13·88
The ash contained:		
Lime	CaO	26·38
Magnesia	MgO	7·30
Potash	K_2O	32·80
Sulphuric anhydride	SO_3	3·75
Chlorine	Cl	2·63

The above figures show that the tobacco was of satisfactory composition. The sample was not, however, prepared in such a way as to meet the requirements of British manufacturers, and in these circumstances it was not submitted for valuation, since any value placed on the tobacco in this condition would not represent the price it should realise if properly cured.

Samples 2 and 3 consisted of pipe tobacco cured by the methods applicable to cigar tobacco, and they do not conform to any type of tobacco used in the United Kingdom. They were not examined chemically.

None of these three tobaccos represents a type largely used by manufacturers in the United Kingdom, and they could only be sold at low prices as nondescript manufacturing tobaccos. The examination of sample No. 1, however, indicated clearly that if properly grown and cured, the tobacco would be readily saleable in the United Kingdom. The ash is rich in potash, so that no difficulty need be anticipated in producing tobacco of good burning quality on the soil on which the sample was grown.

Third Series

Seven samples of tobacco grown experimentally at Kabete, under the supervision of the Adviser for Tobacco, were received in December 1912. The following particulars regarding the experiment were supplied.

The American varieties tried were Hester, Goldfinder, Yellow Oronoco, Ragland's Improved Yellow Oronoco, and Stirling. The following Levantine varieties were also sown. Smyrna, via Rhodesia, Turkish seed from the United States, and Cavalla and Ayasalouk, the last two being supplied by the Imperial Institute.

The seed was sown February 1 to March 8, 1912, and planting out was started on April 8 and continued to May 25. In spite of the fact that the plantation was treated with a mixture of "Paris Green" and bran, "cutworm" did considerable damage, some plots having to be replanted five times.

The American varieties were planted 3 ft. by 3 ft., whilst the Turkish varieties were planted 6 to 8 in. apart, with 2 ft. between the rows.

The young plants were kept well cultivated and were sprayed from time to time with insecticides and fungicides.

This kept insect pests and fungoid diseases in check for some time, but the rainfall was greater than usual, followed by several months of cloudy weather, with the result that the plants became attacked with white mildew, which destroyed a large quantity of the crop. This was especially bad amongst the Turkish tobacco.

Most of the American tobacco grew well in the field, but the leaf was of a very dark green colour. The "Goldfinder" was rather large and coarse. The same remarks apply to the Turkish tobacco, of which the "Cavalla" variety had the best appearance.

Reaping of the Turkish leaf was begun on June 11, and continued to October 11, but throughout this period there was little sunshine, and the leaf remained to a large extent green, whilst the amount of moisture in the air caused the exposed part of the leaf to darken considerably.

The first reaping of American tobacco was made on June 28, and the last on September 30. The greater part of this leaf was cured in the flue-barn, but, though many methods were tried, it was found impossible to get the leaf to cure a good colour, the green always predominating. The Adviser for Tobacco, therefore, considers that tobacco grown on the red soil of Kabete would give better results if "air-cured."

The samples examined at the Imperial Institute were as follows:

No. 1. "*Sterling Bright.*"—The leaves varied in size from 16 by 6 in. to 20 by 10 in., and were mostly of a dull orange-brown colour, with greenish patches. They were fairly uniform in colour and size, moderately tough, and of fine texture.

The tobacco burnt moderately well, leaving a grey, flocculent ash. The smoke was of rather strong flavour and the aroma somewhat pungent.

No. 2. "*Ragland's Improved Oronoco.*"—The leaves varied in size from 17 by 7 in. to 25 by 9 in., and were mostly of a dull yellowish-green colour, though a few were brown with a greenish tinge. They were of moderate thickness, and fairly tough: some leaves showed green patches.

The tobacco burnt fairly well, leaving a dull grey ash with white edges. The smoke was mild in flavour and aroma, but not very pleasant.

No. 3. "*Hester.*"—The leaves were fairly uniform in size, the smallest being 20 by 9 in. and the largest 25 by 9 in. They were coarse in texture, fairly tough, and were mostly of dull brown colour. A few "burns" were noticed in some cases, but the majority of the leaves appeared to be free from such defects.

The tobacco burnt fairly well, leaving a nearly white ash. The flavour and aroma of the smoke were mild, but not very pleasant.

No. 4. "*Ayasalouk.*"—The leaves were irregular in size, varying from 4½ by 2 in. to 12 by 5 in., the average being about 8 by 3½ in. The leaves varied in colour from dull greenish-yellow to a dull brown, and were moderately fine in texture but fairly tough. The aroma of the tobacco was poor.

This tobacco burnt fairly well, leaving a pale grey ash. The flavour and aroma of the smoke were mild, but only slightly reminiscent of Levantine tobacco.

No. 5. "*Cavalla.*"—The leaves varied in size from 4 by 1½ in. to 12 by 4 in., with an average of about 9 by 3½ in. In general the sample was of dull brown colour, but it was not very uniform in this respect. The leaves were of fine texture and fairly tough. They were a little more aromatic than those of sample No. 4.

The tobacco burnt fairly well, leaving a nearly white ash. The flavour and aroma of the smoke were rather pungent, and only slightly reminiscent of Levantine tobacco.

No. 6. "*Turkish, from Smyrna seed.*"—The leaves were fairly uniform in size, the smallest measuring 8 by 3 in., and the largest 12 by 5 in., with an average of about 10 by 4 in. They were mostly of dull brown colour, of fine texture and fairly tough.

The tobacco burnt well, leaving a grey ash. The smoke had a rather pungent flavour and aroma, only slightly reminiscent of Levantine tobacco.

No. 7. "Turkish, from seed obtained from United States."—The leaves varied in size from 6 by 2½ in. to 13 by 5½ in., with an average of about 9 by 3½ in., and were mostly of dull brown colour. They were fine in texture and fairly tough.

The tobacco burnt moderately well, leaving a nearly white ash. The flavour and aroma of the smoke resembled those of sample No. 6.

Samples 2, 3, 5, and 6 were submitted to chemical examination, the results of which are given in the tables on pp. 597, 599.

Commercial Valuation

The samples were submitted to three firms of manufacturers, who furnished the following reports:

(1) The first firm, after testing the samples, valued them in London as follows (March 1913):

Sample.	Variety.	Value per lb.
1.	Sterling Bright	about 6*d.*
2.	Ragland's Improved	about 4*d.*
3.	Hester	about 5*d.*
4.	Ayasalouk	about 5*d.* to 6*d.*
5.	Cavalla	
6.	Turkish, from Smyrna seed	
7.	Turkish, from seed obtained from the United States	

The firm added that samples 4 to 7 had very little flavour or character, and were too dark and not sufficiently aromatic to be satisfactory for cigarette purposes.

(2) A second firm considered samples 1, 2, and 3 to represent products which could only be used sparingly in the cheapest pipe tobaccos, and which would have to be sold at a lower rate than Virginia or Kentucky tobacco in order to find a market.

(3) Samples 4 to 7 were submitted to a third firm, who were of opinion that these tobaccos might perhaps be used for blending purposes, and considered that the inferior aroma of the samples was probably partly due to imperfect fermentation.

Remarks and Recommendations

"*Virginian*" *tobaccos.*—For convenience of discussion the analytical results obtained with Nos. 2 and 3 of these tobaccos are summarised in the following table in comparison with the results of the examination at the Imperial Institute of Nyasaland tobaccos of the same type.

	East African tobaccos.		Nyasaland tobaccos.		
	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	5·02	4·92	9·9	8·9	8·8
Total alkaloids (nicotine, etc.) .	3·20	5·15	1·2	2·2	1·5
Total nitrogen	3·84	4·46	1·3	2·2	1·5
Ash	22·67	17·21	14·4	8·1	8·7
Composition of ash :					
Lime CaO	33·20	33·56	17·4	36·3	26·8
Magnesia MgO	7·11	9·95	5·7	9·3	8·8
Potash K_2O	22·43	22·30	30·0	22·8	32·6
Sulphates, expressed as sulphuric acid SO_3 .	4·17	5·01	1·9	3·7	2·2
Chlorides, expressed as chlorine Cl .	0·66	0·90	0·4	2·2	0·3

It should be pointed out in the first place that the chemistry of tobacco is not yet so well developed that the results of analysis of a sample of tobacco can be regarded as an infallible guide in forming an opinion of its quality, and such results must still be supplemented by subjective tests made by experts having a knowledge of the requirements of the tobacco market. Such tests are, however, incomplete from the point of view of the producer of raw materials, since being subjective they are, so far as new tobaccos are concerned, little more than expressions of opinion reflecting the particular tastes of the experts who make the tests. The results of both these methods of examination are therefore given in this report.

The table given above shows that these East African tobaccos contained unusually small amounts of moisture when received, that is, they were packed too dry. This, however, is a matter of small importance at the present moment, since it will be easy to pack the tobacco in such a state that it will reach this country containing from 10 to 12 per cent. of moisture, which is sufficient to keep the leaves in good condition for handling.

Much more important are the amounts of nitrogen and nicotine, which are higher than those found in the Nyasaland tobaccos, though they are not outside the range that has been recorded for Virginian tobaccos. The quantities of ash are also higher than those in the Nyasaland tobaccos, though again they are not outside the recorded range for Virginian tobaccos. The composition of the ash is fairly satisfactory, though on the whole there is less of the desirable constituent potash, and more of the undesirable components, sulphates and chlorides, than in the Nyasaland tobaccos with which the present samples are compared.

The Adviser for Tobacco makes it clear in the letter forwarded with these samples that the season in which these tobaccos were grown was unfavourable, and he was also apparently of opinion that the soil on which they were grown was not quite suitable for this kind of tobacco. The results of examination of these samples support the view that the soil at Kabete is unsuitable for this kind of tobacco, though they are not quite conclusive on this point, because the unfavourable climatic conditions would also tend to modify the composition of the tobacco in the same direction as the soil, supposing, as seems to be the case, that the latter is too rich in nitrogen and rather rich in lime.

It was recommended that in the next season the experiments should be continued with Virginian tobacco at Kabete, with the following objects:

(1) To produce a dark air-cured "Virginian" leaf.

(2) To try the production of "bright Virginian" leaf on Kabete soil which has borne two or three crops of maize or other cereal.

(3) To produce "bright Virginian" leaf on the plots which furnished the tobaccos now under report.

At the same time a plot of cigar tobacco should be tried at Kabete.

Trials with "Virginian" tobacco should also be made elsewhere in the Protectorate, on a soil obviously better suited to "bright Virginian" tobacco than that at Kabete. The soils of the Kibwezi district, judging from the analyses quoted by the Adviser for Tobacco (see p. 588), should be suitable for such a trial.

Levantine Tobaccos—The results of examination of two of the four samples (Nos. 4 to 7) of Levantine tobaccos submitted are summarised in the following table, in comparison with those of commercial Levantine tobaccos.

	East African samples. Levantine types.		Commercial samples of Levantine tobaccos.		
	No. 5.	No. 6.	Macedonian	Greek.	Samos
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	7·20	6·92	9·4 to 10·9	8·9 to 10·6	9·9
Total alkaloids (nicotine, etc.)	0·88	0·82	0·91 to 2·90	2·2 to 3·1	0·79 to 1·6
Total nitrogen . . .	3·72	3·71	2·00 to 2·50	3·1 to 4·4	1·6 to 2·2
Ash	15·83	13·71	9·30 to 13·20	11·8 to 15·3	10·6 to 14·8
Composition of ash:					
Lime CaO	31·42	24·28	39·12 to 58·8	30·7 to 45·7	40·0 to 44·2
Magnesia MgO	10·35	8·81	5·34 to 7·9	1·7 to 10·9	4·5 to 13·3
Potash K_2O	22·24	25·97	6·87 to 12·67	7·4 to 20·6	7·3 to 13·2
Sulphates, expressed as sulphuric acid SO_3	5·90	5·82	2·57 to 4·25	2·5 to 4·5	4·1 to 9·0
Chlorides, expressed as chlorine Cl	1·27	0·97	traces to 1·38	0·29 to 1·9	traces to 3·38

These "Levantine" tobaccos from East Africa have defects of the same type as those noted in the case of the "Virginian" tobaccos, defects which are probably due to the cultivation of the tobaccos on a soil too rich for these types, but which may also be in part due to the unfavourable season.

The experiments with Levantine types of tobacco should, however, be continued on the lines suggested on p. 598 for further experiments with "Virginian" tobaccos.

General Conclusions

The results of the examination of these seven samples of tobacco indicate that the tobaccos have been grown under conditions which have induced too rank a growth. These conditions are probably over-richness of soil and excess of moisture in the atmosphere. Some of the effects of these unfavourable conditions have been reduced by the process of curing, but owing, no doubt, to the very unfavourable climatic conditions of the 1912 season, the improvement thus induced is not sufficient to make the tobaccos of good commercial quality. The tobaccos are, however, quite as good as could be expected in a first experiment, and the results of their examination afford reasonable ground for the belief that when a type of tobacco suitable to the soil has been found it will be possible to grow tobacco of excellent quality in East Africa in normal seasons. The further experiments suggested on pp. 598 and 599 should afford assistance in this direction.

In view of the importance of finding a tobacco suitable for cultivation on the soil represented at Kabete, it is very desirable that cigar types of tobacco should be tried there.

COTTON GROWING IN THE GOLD COAST

COTTON has been grown on a small scale in the Gold Coast for many years for the manufacture of native cloths, but comparatively little has been exported. The variety grown by the natives is a perennial type and of very mixed nature. Attempts have been made by the Local Department of Agriculture and by the British Cotton Growing Association to encourage the natives to extend the cultivation, but so far with little success, owing to the fact that more lucrative crops, such as cocoa, can be grown, while the collection of oil palm products gives them a larger return with less labour.

In 1903 a Cotton Expert was appointed and large quantities of seed of American varieties were distributed to the natives, and small experimental areas, under the supervision of native chiefs, were established in a few selected districts. A cotton farm was established at Labolabo, in the Eastern Province, near the Volta river, and the early experiments, especially with American varieties, gave promising results. Improved American Upland cottons, including "Black Rattler," "Richmond," and "Georgia," gave yields of seed-cotton ranging from 450 to 730 lb. per acre, with an average of 501 lb.; four strains of native cotton gave an average yield of 369 lb., but "Mitafifi" cotton yielded only 215 lb. per acre. In 1906 the entire supervision and management of the development of cotton cultivation in the Gold Coast was undertaken by the British Cotton Growing Association, who took over the experimental plantation at Labolabo and erected a steam ginnery with three saw gins there, the Government having decided to assist only with monetary grants. The progress in this district, however, was slow, and in 1909 the Association gave up the experimental work at Labolabo, but continued to maintain the buying and ginning station at this place. In the same year a Government Experimental Station was established at Tamale in the Northern Territories, at which special attention is being devoted to cotton cultivation. At this station systematic experiments have been arranged to determine a suitable and profitable rotation of crops to grow with cotton; to ascertain the best variety to grow; to produce, by selection and cross-fertilisation, improved strains of cotton, and also to find out the best times at which the different varieties should be planted. Experiments are also being conducted at the Government Experimental Station at Assuantsi, in the Central Province of the Gold Coast Colony.

In recent years particular attention has been paid by the British Cotton Growing Association to possible developments in the Northern Territories, and a small buying and ginning station was opened at Tamale, but the results so far have been disappointing. The British Government, however, have renewed for a period of three years a grant of £10,000 per annum to the Association towards the cost of their work in Nyasaland, Nigeria, and the Gold Coast, and the Association, according to their *Annual Report* for 1912, have therefore decided to carry on the work in the last-mentioned country for a further period. Arrangements have also been made by the Association to continue the buying station and ginning factory at Labolabo.

The Director of Agriculture in his report for 1911 states that cotton for the most part must be grown in the Gold Coast as a catch crop amongst foodstuffs, but even under the most favourable conditions only a very small yield per acre can be expected.

The exports of raw cotton from the Gold Coast in recent years, according to the official statistics, are as follows:

	Quantity. *lb.*	Value. £
1908	51,480	1,171
1909	31,290	790
1910	11,421	263
1911	9,701	238
1912	20,395	506

A considerable number of samples of cotton grown in the Gold Coast have been examined at the Imperial Institute. Some of the earlier samples were dealt with in *British Cotton Cultivation: Reports on the Quality of Cotton grown in British Possessions* (*Colonial Reports, Miscellaneous Series, No.* 50 [Cd. 3997], 1908, p. 28), and in this BULLETIN (1909, **7**, 14). In the following pages an account is given of the cottons received since that date. They comprise Improved American Upland and native varieties as well as a series of hybrid cottons produced at the Labolabo experimental plantation.

Improved American Upland Cottons

No. 1. *Nyasaland Upland.*—A sample of seed-cotton and one of lint grown at Labolabo were received in March 1911. The former yielded 32·8 per cent. of lint on ginning, the yield per 100 seeds being 4·2 grams. The seeds were of medium size and covered with a white fuzz.

The cotton was clean, fairly soft, moderately fine, lustrous, and of white to pale cream colour with occasional small yellow stains. It was of uneven strength, some portions being rather weak. The length of the fibres varied from 1·0 to 1·5 in., but was mostly from 1·2 to 1·3 in.

This cotton was of good quality, but was somewhat neppy, *i.e.* it contained specks or knots consisting of short, unripe fibres, and portions of it were rather weak. It was valued at about 6½*d.* per lb., with "middling" American at 5*d.* per lb. It was pointed out that if it was intended to grow this cotton in the future on a large scale in the Gold Coast great care would be required in connection with its acclimatisation. It was stated that it was of the highest importance that seed for sowing should be carefully selected from those plants which showed the most desirable characters, and that this process should be repeated from year to year until a permanent type had been established. In this connection, reference was made to the method of selection recommended for this variety of cotton by the Director of Agriculture in Nyasaland in his report for 1909–10, which has been reprinted in this BULLETIN (1910, **8**, 372).

No. 2. Nyasaland Upland.—A sample of seed-cotton of this variety, which had been grown at Tamale, was received at the same time as the preceding sample. The yield of lint on ginning was 33·4 per cent., and the yield per 100 seeds 4·55 grams. The seeds were of small to medium size; some were coated with a white or greenish fuzz, whilst others were smooth and black, with a tuft of down at the pointed end.

The lint was clean, fairly soft and lustrous, moderately fine, of white to pale cream colour, and free from stains. It was of somewhat uneven strength, and varied in length from 1·0 to 1·5 in., but was mostly from 1·2 to 1·3 in.

This cotton was of very satisfactory quality and somewhat superior to the preceding sample of Nyasaland Upland from Labolabo, being of better lustre, free from stains, and not neppy. The chief defect was the irregular strength. It was valued at about 7*d.* per lb., ginned, with "middling" American at 5*d.* per lb. The cotton was very similar to samples of the same variety grown in Nyasaland which have been examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 528).

No. 3. Nyasaland.—A second sample of Nyasaland seed-cotton grown at Tamale was received in July 1913. It yielded on ginning 30·2 per cent. of lint, the yield per 100 seeds being 3·22 grams. The seeds were of medium to large size, and mostly bearing varying quantities of long white, brownish, or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, slightly "leafy," soft, lustrous, and of cream colour, with a few small and large yellow or brownish stains. The strength of the cotton was irregular, but fair on the whole. Some weak immature fibre was present. The fibres varied in length from 0·8 to 1·4 in., but were mostly from 0·9 to 1·1 in.

This sample was very short for Nyasaland Upland and was decidedly inferior to that usually produced in Nyasaland. It was valued at 7½*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 4. *Black Rattler.*—A sample of seed-cotton and one of lint of this variety, which had been grown at Tamale, were received in March 1911. The former yielded 39·0 per cent. of lint, the yield per 100 seeds being 5·21 grams. The seeds were small, in some cases covered with white or green down, whilst others were smooth and dark brown with a tuft of down at the pointed end.

The lint was clean, slightly coarse, fairly lustrous, of white to pale cream colour, and free from stains. It was of good strength, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·0 in.

This cotton was of satisfactory quality, but rather short and somewhat neppy. It was valued at about 5*d.* per lb., with "middling" American at the same price.

No. 5. *Black Rattler.*—This sample of seed-cotton was also grown at Tamale, and was received in July 1913. The yield of lint on ginning was 35·7 per cent., and the yield per 100 seeds 4·05 grams. The seeds were of medium to large size; some were dark brown, without fuzz, and others bore quantities of long white, brownish, or greenish fuzz.

The lint was clean, soft, lustrous, and of cream colour with occasional yellow or brownish stains. The strength was rather irregular, but fairly good on the whole. The length was also irregular, varying from 0·8 to 1·4 in., but mostly from 0·9 to 1·1 in.

The value of this cotton is reduced by its uneven length and strength, as well as by the presence of stains. It was valued at 6½*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 6. *Black Rattler.*—This sample of seed-cotton was grown at Assuantsi, and was received in March 1911. It yielded on ginning 38·4 per cent. of lint, the yield per 100 seeds being 5·6 grams. The seeds were of medium size, and mostly covered with grey or green down, whilst a few were smooth and dark brown with a tuft of down at the pointed end.

The lint was soft, fairly fine and lustrous, of white to cream colour, and free from stains. The strength was fairly good, and the length ranged from 0·7 to 1·1 in., but was mostly from 0·9 to 1·0 in.

This sample of Black Rattler cotton was very similar to No. 4 from Tamale, but was slightly superior, being less neppy. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb.

No. 7. Jones's Improved.—This sample of seed-cotton grown at Tamale was also received in March 1911. The yield of lint on ginning was 35·5 per cent., the yield per 100 seeds being 6·3 grams. The seeds were large and covered with a fuzz varying in colour from pale brown to green.

The lint was clean, fairly soft, lustrous, fine, of cream colour, and free from stains. The strength was uneven, most of the cotton being rather weak. It was of irregular length, the fibres varying from 0·7 to 1·3 in., but mostly from 0·8 to 1·0 in.

This sample was inferior to the usual growth of "Jones's Improved" cotton, being of short and irregular length and uneven strength. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb. If the plant were carefully acclimatised it would probably yield a product of more regular character.

No. 8. *Jones's Improved.*—A further sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. It yielded on ginning 34·4 per cent. of lint, the yield per 100 seeds being 3·9 grams. The seeds were large, and mostly covered with long white, brownish, or greenish fuzz; a few dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, and of cream colour, with a few small yellow or greenish stains. It was of fairly good strength, and varied in length from 0·9 to 1·2 in., but was mostly from 1·0 to 1·1 in.

This cotton was unusually short for the "Jones's Improved" variety. It was valued at 6⅜*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 9. *Jones's Improved.*—This sample of seed-cotton was grown at Assuantsi, and was received in March 1911. The yield of lint, on ginning, was 35·3 per cent., and the yield per 100 seeds 4·9 grams. The seeds were of medium size, and mostly covered with a pale brown down, whilst a few seeds were smooth, and bore tufts of down at the pointed end.

The lint was clean, fairly soft and lustrous, fine, white to deep cream in colour, and free from stains. It was of good strength and varied in length from 0·7 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This material was very similar to the sample of "Jones's Improved" cotton from Tamale (No. 7), but it was a little stronger. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb.

No. 10. *Hawkins.*—A sample of seed-cotton grown at Assuantsi was received in March 1911. It yielded, on ginning, 36·4 per cent. of lint, the yield per 100 seeds being 5·3 grams. The seeds were of medium size, and were mostly smooth, with small brownish tufts at the pointed end, whilst a few seeds were covered with a pale brown down.

The lint was clean, fairly soft, fine, moderately lustrous, of cream colour, and free from stains. It was of irregular strength, and varied in length from 0·7 to 1·3 in., but was mostly from 0·9 to 1·0 in.

This sample resembled the sample of "Jones's Improved" cotton from Tamale (No. 7), and the remarks made regarding the latter sample apply also in this instance. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb.

No. 11. *Hawkins.*—A sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. The yield of lint, on ginning, was 33·2 per cent., and the yield per 100 seeds 4·43 grams. The seeds were large, and covered with varying amounts of long, white, brownish, or greenish fuzz.

The lint was clean, soft, lustrous, and of cream colour with occasional fairly large yellow or brownish stains. The strength of the cotton was irregular, and on the whole rather poor. It varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This sample was rather shorter than is usual for cotton of the "Hawkins" variety, while its value was further reduced by its uneven length, as well as by the presence of stains. It was valued at *7d.* per lb., with "middling" American cotton at the same price.

No. 12. *Upland.*—This seed-cotton was grown at Tamale, and was received in July 1913. It yielded on ginning 32·2 per cent. of lint, the yield per 100 seeds being 3·96 grams. The seeds were of medium to large size, and mostly covered with varying amounts of long white, brownish, or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, and of cream colour, with occasional small yellow or brownish stains. It was of irregular strength, but on the whole fairly good. The length was also irregular, the fibres varying from 0·8 to 1·5 in., but mostly about 0·9 to 1·1 in.

This cotton was somewhat less stained than No. 11, but exhibited the same defects with regard to length and strength. It was valued at 6¾*d.* per lb., with "middling" American cotton at *7d.* per lb.

Native Cottons

No. 13.—This sample of seed-cotton, which was received in April 1909, was grown experimentally on the Ankobra river, near Axim. The name of this variety was not stated, but it was probably a native cotton. It yielded 39 per cent. of rather rough, fairly lustrous lint of pale cream colour, with a large proportion of brown and yellow stains. The seeds were rather large, smooth, dark brown, with light brown tufts at the pointed ends. Groups of from two to six lightly adhering "kidney" seeds were occasionally noticed. Thirty per cent. of the seeds examined were withered, and would be useless for sowing.

The cotton was of uneven strength, some portions being very weak. The length of the fibres varied from 1·2 to 1·6 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

This sample was valued at about *6d.* per lb. ginned, with "middling" American at 5·54*d.* per lb., but although worth more than "middling" American cotton it was depreciated in value by the large proportion of stains, which appeared to have been caused by insect pests in the crop. If the cotton could be produced clean and free from stains it would probably be considerably more valuable than "middling" American, as it is of very good length. The somewhat high yield of lint on ginning is probably to be attributed to the large percentage of withered seeds in the sample rather than to a naturally high proportion of lint to seed.

No. 14. *Green Seed.*—This sample of ginned cotton was received in July 1909. It was very clean, fairly soft, lustrous, of very even pale cream colour, and entirely free from stains. The strength was uneven, some portions being rather weak. The length of the fibres varied from 1·0 to 1·4 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00079 in.

This cotton had been hand-ginned, and cleaned by the native "bowstring" method, which had very completely removed all portions of "leaf" and broken capsules. Commercial experts stated that the sample was "wonderfully clean." The cotton was somewhat harsher than ordinary American cotton, and was rather weak, but it was of satisfactory quality, and might be used in place of American Upland. It was valued at about *7d.* per lb., with "middling" American at 6·39*d.* per lb.

No. 15. *Green Seed.*—A sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. It yielded on ginning 32·9 per cent. of lint, the yield per 100 seeds being 4·37 grams. The seeds were large, and covered with long, brown, bright green, or white fuzz; a few dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, varying in colour from light brown to almost white, with several small yellowish or brownish stains. It was rather irregular in strength, but good on the whole. The length of the cotton was very irregular, varying from 0·8 to 1·7 in.

This cotton was thought to be worth 6½*d.* per lb., with "middling" American cotton at 7*d.* per lb. Its value was reduced by its uneven colour and irregular length.

No. 16.—This sample of ginned cotton, which was also received in July 1909, was stated to be the ordinary Northern Territories variety, and was grown on the Labolabo Plantation. It was clean, fairly soft, but not very lustrous, of pale cream colour, and generally free from stains. The strength was normal, and the length varied from 0·9 to 1·2 in., the diameter of the fibres ranging from 0·0005 to 0·0010 in., with an average of 0·00076 in.

This cotton was somewhat harsher than Upland cotton, but it would have similar commercial applications, and would be readily saleable. It was valued at about 6·70*d.* per lb., with "middling" American at 6·39*d.* per lb.

No. 17.—This sample, which was stated to be "Tudome native, a Peki variety," was received at the same time as the preceding sample. It consisted of clean ginned cotton, rather rough, not very lustrous, but of even cream colour, and entirely free from stains. It was of normal strength, and varied in length from 1·0 to 1·3 in.; the diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00082 in.

This cotton was valued at about 6·90*d.* to 7*d.* per lb., nominal, with "middling" American at 6·39*d.* per lb. It was of similar character to Peruvian cotton, and it is possible that it might have similar commercial applications, in which case it would realise a higher price than that quoted. The sample was of very good appearance, and cotton of this quality would be readily saleable.

No. 18.—This cotton from the Dagomba district, Northern Territories, was received in March 1911. It consisted of ginned cotton, clean, somewhat harsh, fairly fine, curly, lacking in lustre, white and free from stains, and fully mature. It was of good strength, and varied in length from 0·9 to 1·1 in.

This cotton was of excellent colour, but of somewhat dull appearance and rather short. It was not rough enough to compete with "rough" Peruvian, but would no doubt find a ready sale. It was valued nominally at 8·67*d.* per lb., with "middling" American at 8·37*d.* per lb. It would be desirable to study the behaviour of this variety under cultivation, and to determine the yield of cotton obtainable, as it possesses the advantage of being already acclimatised and would probably give a valuable crop.

No. 19.—A sample of seed-cotton and one of the lint of a native variety grown at Peki were received in March 1911. The former yielded 36·1 per cent. of lint, on ginning, the yield per 100 seeds being 5·6 grams. The seeds were small and dark brown and were free from fuzz, except for a small tuft at the pointed end.

The lint was rather harsh, of fair lustre, of white to pale cream colour, and free from stains. It was of good strength and varied in length from 0·8 to 1·3 in., but was mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·0007 to 0·0011 in., with an average of 0·00080 in.

This sample was of good useful quality, and the cotton would be well worth cultivating. It is probable that it might be considerably improved by careful seed selection. It was valued at about 5¼*d.* to 5½*d.* per lb., with "middling" American at 5*d.* per lb.

No. 20. *Dagomba Native.*—A sample of seed-cotton, and one of the lint of this variety grown at Tamale, were received at the same time as the preceding sample. The seed-cotton yielded, on ginning, 26·2 per cent. of lint, the yield per 100 seeds being 2·5 grams. The seeds were rather small and more or less covered with a white down.

The lint was clean, soft, fairly lustrous, of pale cream colour and free from stains. It was rather weak, and varied in length from 0·8 to 1·3 in., being mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·0006 to 0·0009 in., with an average of 0·00078 in.

This sample was similar to the preceding sample of native cotton grown at Peki (No. 19), but was somewhat softer. It was valued at about 5½*d.* per lb., with "middling" American at 5*d.* per lb. The cotton is of good serviceable quality and could doubtless be improved by cultivation. The yield on ginning, viz. 26·2 per cent., is rather low.

No. 21. *Dagomba Native.*—This seed-cotton was grown at Tamale and received in July 1913. It yielded on ginning 27·9 per cent. of lint, the yield per 100 seeds being 2·54 grams. The seeds were of medium size, and mostly covered with long white, brownish or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, of cream colour, and practically free from stains. It was of fairly good strength, but rather irregular in length, varying from 0·8 to 1·3 in., but mostly from 0·9 to 1·1 in.

This sample was of very good appearance, but was a little irregular in length. It was valued at 6¾*d.* per lb. with "middling" American cotton at 7*d.* per lb.

No. 22.—A sample of ginned cotton and one of cotton seeds of an indigenous variety, from the Gambaga District of the Northern Territories, were received in April 1913. The lint was clean, rather harsh, curly, of moderate lustre, of pale greyish-cream colour, and free from stains. The seeds were of medium size, and covered with fairly long bright green or brownish fuzz.

The cotton was of fair strength, but rather irregular in length, varying from 0·8 to 1·5 in., but mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·00060 to 0·0013 in., with an average of 0·00085 in. On microscopical examination it was found that many of the fibres were deficient in twist, probably owing to lack of cultivation of the plant.

This cotton was rather coarse and harsh, and possessed to some extent the characteristics of wild cottons. The fibre was, however, of promising quality and could possibly be considerably improved if the plants were systematically cultivated. On account of its rough character it would probably be of special value for admixture with wool in the manufacture of the so-called "union" yarns. It was valued at from ½*d.* to 1*d.* per lb. in advance of "middling" American cotton, which at the date of the report was quoted at 6·79*d.* per lb. (May 1913).

Herbarium specimens forwarded with the cotton were identified at the Royal Botanic Gardens, Kew, as *Gossypium arboreum*, Linn. Several samples of this species of cotton from Northern Nigeria have already been examined at the Imperial Institute (see this BULLETIN, 1913, **11**, 76).

No. 23. *Native Black Seed.*—This seed-cotton was grown at Tamale, and was received in July 1913. The yield of lint on ginning was 27·4 per cent., and the yield per 100 seeds, 2·44 grams; the seeds were of medium size, and covered with long white or brownish fuzz; a small number of dark brown seeds without fuzz were also present.

The lint was clean, fairly soft, of fairly good lustre, and varying in colour from a brownish tint to almost white, with several small yellow or brownish stains. It was of fairly good strength, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This cotton was of rather poor colour and appearance. It was valued at 6¼*d.* per lb. with "middling" American cotton at 7*d.* per lb.

No. 24. *Peki.*—This seed-cotton was also grown at Tamale, and was received at the same time as the preceding sample. It yielded on ginning 36·4 per cent. of lint, the yield per 100 seeds being 5·57 grams. The seeds were large and dark brown, without fuzz; many adhered together in "kidneys" of six seeds, which were mostly more or less broken up during ginning.

The lint was clean, slightly harsh, lustrous, and of cream colour, with several small yellowish or brownish stains. It was of good strength, but rather irregular in length, varying from 0·8 to 1·5 in., but mostly from 1·1 to 1·3 in.

This cotton was on the whole of very satisfactory quality. It was valued at 7*d.* per lb. with "middling" American cotton at the same price.

Hybrid Cottons

The following samples of ginned cottons were received in October 1909. As already mentioned, they were produced experimentally at the Labolabo Plantation. At the date of valuation of the samples "middling" American cotton was valued at 6·79*d.* per lb.

No. 25. *Green Seed on Black Rattler.*—This cotton was clean, fairly soft, of good lustre and even cream colour; entirely free from stains. It was of normal strength, and varied in length from 1·2 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This cotton generally resembled that grown from a good type of "improved" American seed. It was slightly harsher than Upland cotton, but was of very good length and of excellent quality. It was valued at 8·79*d.* per lb. (nominal).

No. 26. Black Rattler on Native.—This sample was similar in appearance to No. 25. It was of very good strength, and varied in length from 1·4 to 1·6 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00071 in.

The cotton was superior in length to the preceding sample, "Green Seed on Black Rattler," but in other respects no difference could be observed. It was valued at 9·29*d.* per lb. (nominal).

No. 27. Peruvian on Native.—Clean cotton, rather harsh, of fair lustre, and of somewhat uneven cream colour with some slight brownish-yellow stains. Some portions were rather weak. The length of the fibres varied from 1·0 to 1·3 in., and their diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00076 in.

This cotton had the style of a native cotton. It was harsher than American Upland, but not sufficiently "woolly" to be comparable with "rough" Peruvian. The cotton, although slightly stained and immature in parts, was of fairly good quality, and would no doubt be readily saleable. It was valued at 6·94*d.* to 7·04*d.* per lb.

No. 28. Black Rattler on Green Seed.—This cotton was clean, rather harsh, of fair lustre and even colour, and generally free from stains. It was of normal strength and varied in length from 1·0 to 1·3 in. The diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00075 in.

Although of better quality, this cotton appeared to be of very similar type to the preceding sample, "Peruvian on Native," and it is possible that these two samples may not be true hybrids, as stated, but simply the native forms. The cotton was valued at 7·09*d.* per lb.

No. 29. *Allen's Improved on Native.*—Clean cotton, rather harsh, lustrous, and of even cream colour; entirely free from stains. The strength was generally normal, and the length varied from 1·2 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00073 in.

This cotton would probably be classed as a good quality of Upland. The material was slightly harsher and deeper in colour than ordinary Upland cotton, but generally resembled it in other respects. It was valued at 7·19*d.* to 7·29*d.* per lb.

No. 30. *Russell's Big Boll on Native.*—This cotton was similar in appearance to the preceding sample, "Allen's Improved on Native." It was of normal strength, and varied in length from 1·1 to 1·4 in. The diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00075 in.

Although slightly inferior in length, this cotton closely resembled the preceding sample, and it was valued at the same price.

No. 31. *Culpepper's Big Boll on Native.*—This was clean, rather harsh cotton, of fair lustre and deep cream colour, with some slight brownish-yellow stains. It was of uneven strength, some portions being rather weak. The length of the fibres varied from 1·1 to 1·3 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This material was slightly harsher than Upland cotton. It was of good quality, and worth from 6·94*d.* to 7·04*d.* per lb., but it was depreciated in value by its somewhat inferior colour.

No. 32. *Richmond on Native Green Seed.*—Clean cotton, rather harsh, of fair lustre and even deep cream colour, and generally free from stains. The strength was generally normal, and the length varied from 1·0 to 1·3 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00075 in.

This material was slightly harsher than Upland cotton, but was of very good quality, and would be readily saleable. It was valued at 7·09*d*. per lb.

No. 33. *Richmond on Volta River.*—Clean cotton, fairly soft, lustrous, and of even deep cream colour; entirely free from stains. Occasional smooth brown seeds, with light brown tufts at the pointed ends, were found in the sample. The cotton was of normal strength, but rather uneven in length, varying from 1·1 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00071 in.

This sample was of very good quality, and about equal to a high grade of Upland cotton. It was valued at 7·19*d*. to 7·29*d*. per lb.

No. 34. *Black Rattler on Volta River.*—This cotton was similar in appearance to the preceding sample, "Richmond on Volta River." It was of normal strength, and varied in length from 1·1 to 1·4 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

This sample, like the preceding, "Richmond on Volta River," was of very good quality, and about equal to a high grade of Upland cotton. It was valued at 7·19*d*. per lb.

No. 35. 1904 *Hybrid.*—Clean cotton, rather harsh, of fair lustre and even cream colour; entirely free from stains. It was of uneven strength, some portions being rather weak. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·0008 in.

Although portions of this sample were immature, and consequently of poor strength, the cotton generally was of very good quality. It was valued at 7·04*d*. per lb.

Several of these eleven samples of hybrid cottons were rather harsh and distinctly "woolly." It was therefore considered possible that they might find a market as rough varieties, similar to "semi-rough" or "rough" Peruvian cotton, in which case they might realise higher prices than those quoted in the present report.

SPECIAL ARTICLES

THE CANADIAN DEPARTMENT OF AGRICULTURE

By J. H. Grisdale, B.Agr.

Director, Dominion Experimental Farms, Ottawa

What is known as the Canadian or Dominion Department of Agriculture, as differentiated from the various Provincial Departments of Agriculture in Canada, has to do with such matters as affect all parts of the Dominion or with lines of work that are of such a character as to be likely to lead to complications should it be attempted to deal with them locally. It must be understood, however, that many of the matters dealt with by the Dominion Department do also receive attention, usually to a more limited extent, from the Provincial Departments.

As at present constituted, those Branches of the Dominion Department of Agriculture having to do with agriculture are: Health of Animals, Live Stock, Dairying and Cold Storage, Seeds, and Experimental Farms, with various other more or less important but subsidiary divisions.

The Health of Animals Branch, under an officer known as the Veterinary Director-General, is charged, of course, with the enforcement of the various laws and regulations for the prevention and control of contagious diseases affecting live stock in Canada. It has likewise to do with the regulations under which live stock may be brought into and taken out of the country. It has in its employ for this purpose many veterinary inspectors scattered throughout the various provinces as well as located at the various ports of entry and animal quarantine stations. The administration of the Meat Inspection Act also comes under this Branch. According to this Act, every abbatoir and meat-packing plant preparing meat of any kind for export must be under the constant supervision of qualified inspectors in connection with their slaughtering, curing, and packing operations.

The Live Stock Branch, under the Live Stock Commissioner, devotes much of its energies to the marketing end of the live-stock industry in the Dominion. Besides this, however, it is concerned with popularising the various selected breeds of horses, cattle, sheep, swine, and poultry, and employs men whose duties are to advance Canadian live-stock interests by lecturing, by judging at small fairs, by taking part in short courses of instruction, and in any and every way that offers. What are known as the National Live Stock Records, while not actually a part of this Branch, may be said to be closely allied thereto. The Canadian Record of Performance for Dairy Cows is another division of this Branch; it, also, is doing good work.

The Dairy and Cold Storage Branch, under the supervision of a Commissioner of Dairying and Cold Storage, concerns itself with the advancement of the dairying interests in a general way throughout the Dominion. Dairying is, of course, a line of work very closely followed by the Provincial Governments, with whose Agricultural Departments this Branch co-operates. This Branch is, however, doing much independent work to advance the interests of dairying, as, for instance, experimenting in the manufacture of butter and Cheddar cheese and in studying methods of milk preservation. Cow Testing Associations are also being organised and helped by this Branch at many points in the country. The Act providing for subventions to cold storage plants used as public cold stores is administered by the Dairy and Cold Storage Branch.

The Seed Control Act is administered by the Seed Branch, at the head of which is the Seed Commissioner. A close inspection is made at the proper time of all stores of seed and of seed of various kinds exposed for sale. Seed is required to be properly graded and to come up to a certain standard as regards purity and vitality. In addition, the Canadian Seed Growers' Association may be said to exist under the ægis of this Branch.

The various Branches already mentioned are concerned more or less exclusively, as is evident, with the encouragement of agriculture by controlling and regulating rather than by investigating and demonstrating. The research and demonstration work done by the Dominion Government in agricultural matters is practically all carried on at one or other of the various Experimental Farms which form the Dominion Experimental Farm System. The Experimental Farms or Stations, together with the substations, now number about twenty-five. They are found in every province and in every latitude from about 46 to 62 degrees, or nearly so, north—a range of approximately 1,100 miles from south to north, and a stretch of country about 3,000 miles from east to west.

The Farm at Ottawa, Ontario, is known as the Central Experimental Farm. On this Farm are located the Director of Dominion Experimental Farms and the various officers in charge of the different lines of investigation both at the Central Farm and at the various Branch Farms and Stations. The latter are under the immediate supervision of officers known as Superintendents, who work conjointly with the Director and the various officers at Ottawa in the conduct of experimental and demonstration work.

The Director is responsible in a general way for the activities of the various officers or heads of Divisions and Branch Farm Superintendents. He is also the executive head of the system, and deals with its general policy and financial business.

The chief officers under the Director, at Ottawa, are ten in number and are known as Dominion officers. They include the Animal Husbandman, Field Husbandman, Cerealist, Horticulturist, Agrostologist, Botanist, Entomologist, Poultry Husbandman, Chemist, and Tobacco Expert.

Recently, owing to the establishment of new Farms and Stations, the increase in the number of officers, and the consequent multiplication of purely executive and directorial duties, the Director, who formerly carried on more or less experimental work under his own personal supervision, has been compelled to discontinue this, and to devote his entire attention to the general supervision of the work of the various officers, and to the formulation of policies and general schemes of work for the further development of the Experimental Farm system.

The Dominion Animal Husbandman is charged with the study of live-stock breeding and feeding operations. Much has already been done to show the possibilities of improving the productive power of the various breeds of horses, cattle, sheep, and swine, in the way of labour performance, meat production, milk yield, or other functions. The research work in this division has indicated the possibility of more economical feeding and more effective methods of working the horse; while, by careful and scientific breeding, farmers have been shown the possibility of increasing the efficiency of their dairy herds by from 50 to 200 per cent. The cattle-carrying power of the average eastern farm has been increased by from 50 to 100 per cent.; while the cost of feeding cattle has been largely reduced by the complete change of methods which followed the introduction of the silo, for which, in Canada, the Experimental Farms Branch may be largely thanked.

Unfortunately the advantages accruing from more economical methods of feeding have been possibly even more than counterbalanced by the increased cost of manual labour and the rising value of land. In spite of this, however, the performance of cultural operations according to methods which have proved most effective, judging by results, and most economical of labour, will keep the cost of crop production as low, if not lower, than when lands were very much cheaper, and when wages were a half or less than half of what they are now.

The Dominion Field Husbandman has to do with crop rotation and soil cultivation. Experiments conducted by this division have demonstrated almost incredible possibilities of soil improvement and crop production, where the cultural operations are thorough, and where scientific methods are followed.

The average farmer in Canada in 1912 expended $10.00 per acre in the way of labour on his farm; he reaped crops to the value of $15.50 per acre on the average, leaving a net profit of $5.50 per acre. On the Experimental Farm at Ottawa, with no special advantages of climate or soil, and having no manure other than that from the farmyard, the expenditure per acre was $11.77 in the carrying out of cultural operations in a thorough and scientific manner, following at the same time suitable rotations; the crops produced averaged $45.47 per acre in value, leaving a net profit of $33.70 per acre, which is over six times greater than the average Canadian farmer, working under quite as favourable natural conditions in every way, was able to achieve.

The attention of the Dominion Cerealist has been given for many years to some of the gravest problems which have confronted new settlers in the prairie provinces. Much time has been devoted to the production and introduction of new and improved varieties of cereals adapted to the peculiar conditions which have been encountered there. The free distribution by post of 5 lb. samples of pure seed grain from Ottawa, and the sale of seeds in quantities of usually from 2 to 5 bushels from the Branch Experimental Farms, have been the chief means by which the superior types of grain have been supplied to the farmers. As a means of instruction, and for the demonstration of the characteristics of the different varieties, many trial plots have been grown every year at each of the Farms.

Spring wheat has naturally occupied the first place in this work, on account of its paramount importance, especially to new settlers. Many thousands of samples of "Red Fife," the old standard variety, have been distributed, especially in Manitoba and Southern Saskatchewan. Selections have been made from this wheat to ensure the maintenance of its purity and to effect improvements if possible. For northern districts and those of higher altitude, early-ripening sorts have been found essential. Many such wheats have been tested from time to time, both imported and new cross-bred kinds. Such varieties as "Preston," "Huron," and "Stanley" served a splendid purpose in making wheat-growing profitable in localities for which "Red Fife" was quite unsuitable; but these wheats have lately been surpassed by "Marquis," a cross-bred sort introduced into Saskatchewan by the Dominion Cerealist in 1907, and which has maintained a triumphal progress ever since, such as has probably never occurred before in the history of agriculture (cf. this BULLETIN, 1912, **10**, 151).

"Marquis" has usually out-yielded "Red Fife" by from 10 to 70 per cent., according to the varying conditions of the test, due to its greater earliness, stiffness of straw, and ability to resist disease. The kernels are hard and exceptionally plump, and of a splendid rich colour. The flour from this wheat is practically indistinguishable from "Red Fife" flour. The highest recorded yields of "Marquis" have been obtained at Indian Head, where in 1910 a field of 5 acres gave more than 53 bushels per acre, and in 1912 a fortieth-acre plot yielded at the rate of 81⅓ bushels per acre. No wonder that "Marquis" wheat has defeated the world in the two greatest wheat contests held since its introduction—at New York in 1911 and at Lethbridge in 1912. Until about the year 1910 "Marquis" wheat was obtainable only from the Experimental Farms, but to-day it is offered for sale by many different firms and individuals. Hundreds of thousands of bushels of this wheat have changed hands during the past winter at good prices, and if one may judge from the correspondence which reaches the Experimental Farms, and from the advertisements in agricultural papers, "Marquis" wheat is to-day more thought of and talked about in Western Canada than all the other varieties of grain together.

But "Marquis" is not the last word in wheat-breeding. This year a much earlier sort, under the suggestive name of "Prelude," is offered to the public (*loc. cit.* p. 152). This wheat ripens about two weeks before "Marquis," produces kernels of remarkable hardness and plumpness, and gives flour of the highest baking strength. It will not yield as large crops as "Marquis," and is not intended to displace that variety, but is adapted to northern districts where "Marquis," especially on summer-fallowed land, is apt to produce too long straw and to ripen too late. Though not expected to produce phenomenal yields, a crop of over 10 bushels obtained in 1912 by sowing 5 lb. on a fifth of an acre is a very satisfactory record to begin with.

Many new cross-bred wheats, ripening earlier than "Marquis" and later than "Prelude," are now being tested, and the introduction of at least one of these may be looked for in the near future. One of the most promising of these varieties, not yet named, produced 54½ bushels of superb seed on an acre field at Indian Head during last season. A similar field of "Marquis" near by ripened two days later and gave 47 bushels per acre.

The progress in barley-breeding has been less rapid owing to the limitations of land and assistance for carrying on the work. Some hundreds of very interesting cross-bred barleys are now under study, including some sorts with remarkably stiff straw, also beardless and hull-less varieties both in the six-row and two-row classes. Thus far the most important result which has reached the public is the introduction of an improved, selected Manchurian barley, which is now being distributed and sold.

Problems in oats are being worked at, and some good selections have been made. Cross-bred sorts are also under study.

In peas a cross-bred variety, "Arthur," now stands at the head of the list for most parts of Canada. It is a round, yellow pea of medium or rather large size, producing the pods chiefly towards the tip of the stem, and giving a very large yield of seed. In addition to its other good qualities, it is the earliest maturing pea of its kind known in Canada. It is hoped that the introduction of this new variety will give a distinct stimulus to the growing of this important farm crop.

The Dominion Horticulturist has immediate supervision on the Central Farm over quite extensive orchards, ornamental grounds, and vegetable gardens, but he is also expected to supervise, in a general way, horticultural operations all over the system. Besides this he is occupied largely in breeding experiments for the production of early and superior varieties of fruits, vegetables, and flowers. The possibilities on these lines of work are exceedingly great, and while progress is necessarily slow, gratifying results seem certain.

The Dominion Agrostologist, like the other officials, spends much of his time in Ottawa, having trial grounds whereon breeding operations with grasses, roots, and other forage plants are carried on. He is responsible for the improvement of forage crop plants in every part of Canada, and has more or less experimental work under way at different points.

The Dominion Botanist has his herbarium in the office building of the Central Farm, but is, of course, familiar with plant life in all parts of Canada, and is at all times ready to identify specimens of plants or to diagnose diseases affecting plants if specimens of plants suffering from the disease are sent him.

The Dominion Entomologist, with headquarters at Ottawa, is occupied primarily in enforcing the regulations of the Destructive Insect and Pest Act. His inspectors are scattered throughout the Dominion, from the Atlantic to the Pacific, and while chiefly occupied in the enforcement of the above-mentioned regulations, also give much attention to the study of insects injurious to plant life. Insects sent in are promptly identified, and where any treatment likely to put an end to their depredations is known, the information is sent at once to the inquirer. One of the members of the staff of the Dominion Entomologist is a skilled apiculturist.

The Dominion Poultry Husbandman, in addition to being in charge of poultry work at the Central Farm, is also indirectly in charge of such work on the Branch Farms. He is available for information or help in every province and district in Canada, and has under way much valuable work at the Central Experimental Farm, where some five acres of land are allocated to experimental work with poultry.

The Dominion Chemist, with commodious laboratories on the Central Farm, is occupied with the study of problems of soil fertility, moisture conservation, utilisation of manures, the feeding values of rough and concentrated cattle foods, etc. Much work is also done on insecticides, food preservatives, and drinking waters. Though the laboratories are at Ottawa, research work on these lines is by no means confined to this one Farm, as many acres of land are devoted to such work on the various Branch Farms throughout the Dominion.

The Tobacco Specialist, the tenth officer of the staff of Chief Officers, has under his supervision two special tobacco-growing Stations, where investigations on methods of growing tobacco and the testing of varieties are being carried on.

At the Branch Farms many lines of work are under way. Problems in soil improvement, crop production, horse, cattle and sheep breeding, beef, milk, and pork production, horticulture, gardening, poultry-raising, bee-keeping, etc., receive attention at them all. While all the farms do more or less work on practically all these lines, almost every Branch Farm is distinguished for special work in some particular branch.

Crop production is naturally one of the most important lines of work on the various Branch Farms, and the work in progress for the last fifteen years has demonstrated in almost every part of the country the importance of the introduction of a suitable crop rotation, along with the thorough application of the well-established principles of soil cultivation as the condition of success. Most extensive experiments to gain information as to methods of cultivation, or soil treatment most effective in conserving soil moisture, have been under way for some time, but it is still too early to report progress.

The investigations into beef production in the various provinces have shown that, while grain-growing is profitable, the combination of grain-growing with beef production is much more remunerative in almost any given year, and incomparably more advantageous in a series of years, especially if the conservation of soil fertility and the steady employment of labour be considered.

The very extensive researches into milk production have tended to elucidate many of the problems that puzzled the dairyman on the farm, and have enabled him and encouraged him to make his dairying operations not only remunerative, but highly profitable, in spite of the rather low prices that are paid for milk and its manufactured products. Where the best methods, as determined by experiment on many of these Farms, are put into practice, results show that from 50 to 200 per cent. of clear profit may be confidently anticipated.

Work with swine on these Farms has helped to solve many of the difficulties that seemed to make profitable pork production, on anything like a commercial scale, almost impossible in many parts of the Dominion, on account of climatic conditions. One of the most notable improvements, which has probably done more than any other to help this industry, was the introduction of the cabin or out-door method of wintering the brood sow. This, together with the clover and mangel ration, rendered it possible for the farmer, even in the coldest parts of the country, to reduce by one-half the cost of producing young pigs fit to start in as feeders, and has, at the same time, more than doubled the chances of good, large, strong litters.

The work with sheep, while not yet so effective as it is hoped it will be ultimately in inducing Canadian farmers to take up this industry on a large scale, is, at the same time, attracting attention by the results obtained, which demonstrate clearly that good profits are possible in this industry, although the rapid falling off in the sheep population in the past few years might lead one to assume the contrary.

Poultry and bees are now coming in for much attention at the Branch Farms, as it is becoming more and more evident that they constitute an excellent combination for the small holder, who is gradually becoming a factor to reckon with in rural life in Canada.

Horticulture, as might be expected, is considered of primary importance on all the Branch Farms. Not only is this the case, but certain of the Farms are recognised as being Horticultural Farms, experimental work with fruit being by far the most important features of their operations. Vegetable gardening also has received much attention, and much exceedingly valuable information as to suitability of varieties and most satisfactory methods of growing, as affected by climatic or soil peculiarities, has been gained.

AGRICULTURE IN HAUSALAND, NORTHERN NIGERIA

By P. H. Lamb

Director of Agriculture in Northern Nigeria

Travellers to Kano have often referred to the fertility of the Hausa plains, and to the intensive methods of farming practised by the Hausa. The object of the present article is to consider how far this reputation for fertility is justified, and to discuss the processes—natural and artificial—by which such measure of fertility as does exist is maintained or otherwise from year to year under the system of agriculture generally in vogue.

In reviewing this subject it should be stated at the outset that the remarks here made have no application to small areas of irrigable land adjoining rivers, which must be put under an entirely separate category. The great bulk of the arable land around Kano consists of gently undulating plains covered with a surface soil of very light, sandy loam, originally derived from crystalline rocks, but greatly metamorphosed by the combined action of wind and water.

The whole country is annually exposed to the "Harmattan"—a dry wind from the north—which blows almost continuously from October to April inclusive. At this season of the year little or no rain falls. Under these circumstances the cultivation of the soil for annual crops is practically limited to the five months beginning with May and ending with September. During this period there is a fairly well distributed rainfall, generally totalling from 25 to 35 in.

The two principal food crops of the Hausas are the millets, *Sorghum vulgare*, and *Pennisetum typhoideum*. Cow peas (*Vigna* spp.), almost invariably grown in conjunction with the cereals, may fairly be classed third in importance. Ground nuts would probably come fourth. Other very common crops grown on a smaller scale than the first four, but generally claiming some attention on every farm, and influencing very materially the dress, and therefore the national identity of the people, are cotton and indigo.

As stated above, travellers when discoursing upon Kano and its environs almost invariably speak of the surrounding cultivation as though it practically amounted to one vast garden of remarkable fertility. Surely in view of the fact that the Kano Province has an area of approximately 28,600 square miles, with a population estimated at 3,500,000, it would be a very remarkable thing indeed if there was not a large area of land under cultivation, and if the whole countryside did not look very green and the ground well occupied, for the only five months in the year when it is possible to make the desert smile.

But to the agriculturist this widespread verdure is hardly conclusive of great fertility. On the other hand, the ready response of the land to the smallest dressing of farmyard manure would seem to go a long way to show that natural fertility is rather the factor lacking.

In the immediate vicinity of large towns, and notably of Kano itself, a considerable quantity of manure of various kinds (principally derived from cattle, horses, sheep, and goats) is available, and is turned to good account, being transported either on the head or by means of pack-donkeys, and applied to the land. In some out-districts herds of cattle, fed in the bush by day, are kraaled on the land at night, thus contributing enormously to its productivity.

But there are very large areas where these advantages cannot be enjoyed, and where the peasant, to support himself and his family, relies on the local empirical system of agriculture, and upon the inherent capabilities of the soil. To this class undoubtedly belongs by far the greater part of the land under cultivation in the Hausa States. As the traveller pursues his journey, hour after hour, and day after day, it is land of this description which continually meets his eye, and which presents endless problems of interest to the student of agriculture.

The following description will give some idea of the method of cultivation most commonly followed:

Ridges are almost invariably thrown up at intervals of about 3½ ft. These are made by turning, with a hand-hoe, two sods each 10 in. wide, face downwards, upon an intervening space of approximately 22 in., which forms the base of the ridge. A third stroke of the hoe is employed to deepen the furrow, the soil so removed being used to cap the ridge. This operation causes the surface weeds and humus rapidly to decay, and the resulting plant foods are in exactly the position where the roots of the young crop can turn them to the best possible account. At the same time the furrows, broken as they are by transverse banks at frequent intervals, not only catch the rain, but are in many cases of such a capacity as to be able to retain the water resulting from a heavy storm, and to impound it until it has had time to be entirely absorbed by the soil.

By leaving the base on which the ridge is formed uncultivated—a custom which may at first strike one as slovenly—an enormous economy of labour is effected, and a compact medium is secured, which nevertheless, owing to the extremely sandy nature of the soil, is at once penetrable to the roots of the plant and pervious to water. At the same time, since the site of the ridge one season generally becomes the furrow during the following season, the plants have the full advantage of 10 in. of cultivated soil, even though the depth of cultivation below mean level be only 5 in.

Subsequent cultivation consists in hoeing, the soil being each time thrown up towards the ridges. The value of this operation is fully appreciated by the Hausa, though the extent to which it is carried out varies here, as in every other country.

Here, as elsewhere, several crops are often grown simultaneously on the same land. So far as yield of food per acre is concerned, this practice has been justified in various parts of the world by actual experiment. No reliable figures are at present available to illustrate the wisdom or otherwise of the custom in Northern Nigeria, but observation would certainly tend to support it.

Scientifically it can be explained in that different crops avail themselves of different plant foods, and draw their supplies from different layers of the soil in varying proportions. Further, they grow and ripen at different times, and consequently turn the soil to better account during the growing season than would be possible for any one crop singly. This is especially important with a sandy soil and tropical climate, which combine to cause a serious loss of nitrates.

Before attempting to answer the primary question as to whether the soils of Hausaland may be classed as fertile, it is necessary to have a clear idea of what is meant by "fertility."

Accepting the definition that the measure of a soil's fertility consists in its capacity for producing crops, then there are two distinct types of fertility, namely, that with which a soil is naturally endowed, as seen to advantage in the Nile Delta, and that induced by man, of which a garden soil or a farm improved by a good tenant may be taken as examples.

Now the agriculture of the Hausa States is typically "extensive," large areas rather than heavy yield per acre being relied on for crop production.

Whereas, under the system of intensive agriculture practised in England, land tends to become more and more fertile, and year by year to produce heavier crops, or in other words to improve in "condition," in Hausaland the reverse is the case. Here the land is cropped from four to eight seasons only in succession, and is then allowed to lie fallow until the recuperative processes of Nature enable it once more to produce profitable crops. Since, therefore, the Hausa makes little or no attempt to induce fertility, but prefers rather to draw upon the bounty of Nature, we need merely consider for the moment the natural fertility of his soil.

But again we are faced by the fact that "fertility" is only a comparative term. In order, however, to arrive at some conclusion in the matter, the grain-yielding capacity of unmanured land here may be compared with that of typical arable land in England as exemplified by the classic experiment at Rothamsted, where a wheat crop has been raised annually upon the same field without manure since 1852, and where, in the year 1900, the yield per acre was still over 12 bushels (equal to 720 lb. of threshed corn). We know by repeated measurement that the yield of threshed corn in Hausaland falls very considerably below this figure before the field is allowed to lie fallow, which generally occurs within six years, and this in spite of the fact that cow peas and indigo (Leguminosæ) are almost invariably grown concurrently with the cereals, and that one year in the six is generally devoted to ground nuts (*Arachis hypogæa*), whereas at Rothamsted all Leguminosæ—even weeds—have been rigidly excluded.

So far then as it is practicable to challenge the claim of Hausaland to so abstract a distinction as fertility, the above considerations are presented as convincing.

There is still the second and far more interesting question of how such measure of fertility as does exist is maintained from generation to generation. What are the agencies tending to increase or destroy it? And can man step in and modify these agencies in such a way as to yield him a more ample harvest?

This at once leads to a consideration of the constitution of the soil and the needs of the plant.

The soil is essentially a medium of a certain chemical composition, with a certain physical constitution, and containing a certain quantity of water, and (in the case of all crop-producing soils) supporting an abundance of micro-organisms. These latter are intimately connected with plant nutrition.

Amongst the foods acquired by the plant through its root, those which are found most generally to control the fertility of a soil are nitrogen, phosphates, and potash. Of these, a study of the crystalline rocks of the country, as well as of the indigenous flora of Hausaland, leads one to believe that the last-named is present in sufficient quantities for the needs of farm crops, while the proportion of phosphates is likely to vary considerably in different localities. The evidence, however, is convincing that the supply of nitrogen is almost invariably deficient.

These general deductions are borne out by an analysis of arable soil from Kano, recently made at the Imperial Institute, which gave the following results:

		Soluble in hydrochloric acid	Soluble in 1 per cent. solution of citric acid.	
		Per cent.	*Per cent.*	*lb. per acre*
Lime	CaO .	0·02	—	—
Magnesia	MgO .	0·05	—	—
Potash	K_2O .	0·05	0·0097	309
Phosphoric acid	P_2O_5 .	0·01	0·0008	25
Ferric oxide	Fe_2O_3 .	0·88	—	—
Total nitrogen	N .	0·03	—	—

Before prescribing a remedy for this state of affairs its cause must first be ascertained.

It is generally believed that the original source of the nitrogen absorbed by plants is the air. This nitrogen is secured from the inexhaustible supply in the atmosphere either by the agency of micro-organisms existing in a state of symbiosis with the host plant, as in the case of Leguminosæ, or by bacteria such as Azotobacter which, by the energy derived from organic compounds existing in the soil, are enabled to fix the nitrogen of the air direct. Small quantities, also, are fixed as ammonia by electrical discharges in the atmosphere and are brought down to the soil by rain.

The nitrogen fixed by the two first-named processes subsequently contributes to the general fertility of the soil by the decomposition of the organic matter, and the breaking down of the nitrogenous matter into simpler amino-compounds, salts of ammonia, nitrites, and nitrates, by specific micro-organisms. It should be remembered, however, that this breaking-down process is not a "source" but merely the "channel" through which the two first-named processes are enabled to exercise to the full their essential functions.

Having reviewed the processes which Nature employs to enrich virgin soils with nitrogen, the means by which the Hausa contrives to impoverish them by raising his food crops may be considered. He waits until May comes, with a temperature generally ranging from 75° to 95° F. in the shade, with frequent warm showers, and then he cultivates his land. The soil has been exposed to a tropical sun for six months previously without rain, which not improbably may have had the effect of greatly reducing the protozoa or amœboid bodies in the soil, which have in recent years been shown to prey upon the nitrifying bacteria.

The result of these conditions, greatly exaggerated by the low specific heat and extremely porous nature of the soil, is the rapid consumption of organic matter and the production of nitrates at an extraordinary speed. In this "hot-bed" the Hausa sows his seed, with the result that within ten days the whole country-side assumes the most beautiful dark green tint and everything grows at a remarkable rate.

This annual phenomenon constitutes the so-called "fertility" of Hausaland.

But in the meantime the soil, in spite of the legumes to be seen in almost every cultivation as an intercalary crop, is rapidly depleted of its nitrogen, not only in the form of crops removed from the land but also as drainage water, to which the floods of August and September owe their origin.

The work of destruction continues until the "Harmattan" in October brings it to a natural conclusion by arresting all plant growth, and gradually also bacterial action. Little restoration can take place in the dry season, and the following year, unless a leguminous crop is taken by way of rotation, the "whipping process" commences again.

But, it may be asked, why does not the Hausa make a wider use of leguminous crops, as is done in Europe, America, and Egypt? The reply is briefly that he merely grows what he needs and consumes what he grows. His staple food is corn, and he does not grow food expressly for his stock, as natural vegetation is available. He therefore has no need for large areas of legumes, and consequently does not grow them.

Having seen how the Hausa farmer destroys the natural fertility of his soil, and having considered Nature's two great processes for securing nitrogen from the air, there are two applications of these processes of special interest in Northern Nigeria which are worth noting.

Firstly there is the predominance of leguminous trees. Acacias abound. Among these may be mentioned *A. Seyal*, *A. albida*, *A. Sieberiana*, *A. Nilotica*, *A. Senegal*, and *A. campylacantha*. But over and above all must be mentioned the ubiquitous *Parkia filicoidea*, which more than any other is responsible for giving to the Hausa States their park-like appearance, and which provides food as well as shade for man and beast. But to say nothing of numerous other useful offices which this tree performs in the native economy, attention must be called to its importance as a great fertiliser, supplying as it does, by its annual fall of leaves, which cover the soil like bracken, not only a rich supply of nitrogen but also ash constituents, brought by its great ramifying roots from the sub-soil.

The second very interesting feature to which it is worth calling attention, in view of recent researches as to the action of sugar in supplying food for nitrogen-fixing bacteria of the Azotobacter group, is the heavy fall of "honey-dew" secreted by aphides on the leaves of *Sorghum vulgare*. So marked is this copious secretion that not only can honey bees be heard busily working in the ripening corn, but also the drippings of "sugar" often form a crust on the surface soil. It would be extremely interesting to ascertain exactly to what extent this deposit is of benefit to the soil flora.

Lastly, it remains to be seen how the Hausa can be induced to aid, rather than baffle, Nature in her untiring struggle to enrich his soil. One obvious means has recently been found. An ever-increasing demand for ground nuts exists in Europe, and by running railways into the heart of the sandy soil areas of Hausaland an unlimited local market for this source of oil can be created (the oil may possibly prove a great motive power and pioneer in the future development of Africa), which will at once bring wealth to the cultivator and fertility to his soil.

Already, indeed, this work has begun, for the arrival of the railway at Kano has within eighteen months given such a tremendous stimulus to ground-nut cultivation in the neighbourhood that the resources of the management are being taxed to the utmost to cope with the traffic. Every available piece of land is being planted up with ground nuts, which yield here at the rate of about 1 ton per acre. What the fixation of atmospheric nitrogen will be it is impossible to say, but its influence on the fertility of the soil will, one would imagine, be at least equivalent in effect to that of a modern cyanamide installation of enormous dimensions.

Another promising field of work lies in the breeding of better stock, which will repay good feeding, and consequently demand of their owner the growth of leguminous forage crops. The growing of these "soil-builders" can be rendered practicable by gradually introducing the use of labour-saving implements and so increasing the area under cultivation.

The full achievement of these possibilities will take time, but their development will have an important influence on the productivity of the country as well as on the well-being of its people.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE CULTIVATION AND PREPARATION OF RICE

Part I

There are several species of the genus Oryza, the family of grasses to which the rice-plant belongs, but the species of greatest importance is *Oryza sativa*, Linn., the common or aquatic rice-plant, of which there are an immense number of cultivated varieties. The wild plant from which the cultivated forms have been derived has been found growing naturally in marshy places in Southern India and Indo-China, and in all probability this region is its original home. Other forms of wild rice, which as far as the structure of the spikelets is concerned might be considered conspecific with *O. sativa*, have been found in North Australia, Borneo, tropical Africa, and South

America. The Canadian wild rice (*Zizania aquatica*, Linn.) and the Manchurian "water-rice" (*Z. latifolia* Turcz.), are quite distinct from the true rices.

The cultivated rice plant is an annual with stems varying in height from 1 to 6 or more ft., furnished with tapering leaves 1 to 2 ft. in length, and upwards of 1 in. in width; the flowers are produced in one-flowered spikelets, in panicles 8 in. to 1 ft. in length, that are at first erect but become arched as the grain ripens; the two pales are persistent, forming the "husk" of the ripe grain, and in some varieties the lower pale is furnished with a stiff awn of considerable length; the grain is enclosed in, but does not adhere to, the persistent pales. The cultivated rices vary greatly in habit of growth and also in the size, shape, weight, colour, consistence, and properties of the grain. Rice, like wheat, will throw up a number of culms if the plants are not too crowded, a process known as "tillering."

Several attempts have been made by botanists to classify the numerous forms of cultivated rice; the most useful systems for practical purposes are those based on the cultural requirements of the plants and their periods of growth. The Japanese botanist, Kikkawa, who has had exceptional opportunities for studying the forms of rice cultivated in the East, has published a useful paper on their classification in the *Journ. of the College of Agric., Univ. of Tokyo* (1912, **3**, No. 2, p. 11). In this paper, the classification proposed groups the varieties according to their habit of growth and cultural requirements, and also according to the characters of the grain. A summary of the grouping used for the classification according to cultural requirements and habit of growth is as follows:

(A) *Aquatic or Lowland Rice.*
(*a*) early; (*b*) medium; (*c*) late.
I. Ordinary Rice.
(*a*) tall; (*b*) medium; (*c*) short.
(1) awned; (2) awnless.
II. Special Rice.
(*a*) giant, (*b*) salt.

(B) *Upland or Hill Rice.*
(*a*) early; (*b*) medium; (*c*) late.
(*a*) tall, (*b*) medium; (*c*) short.
(1) awned, (2) awnless.

The points of distinction used for classifying the varieties, including both aquatic and upland rices, according to the grain are:

- (A) *Non-glutinous Rice.*
  - I. Slender-grained. II. Long-grained. III. Short-grained.
    - 1. Large-grained. 2. Medium-grained. 3. Small-grained.
      - (*a*) Common coloured.
        - (A) Ordinary. (B) Scented.
      - (*b*) Specially coloured.
- (B) *Glutinous Rice.*
  - I. Slender-grained. II. Long-grained. III. Short-grained.
    - 1. Large-grained. 2. Medium-grained. 3. Small-grained.
      - (*a*) Common coloured. (*b*) Specially coloured.

The primary grouping into aquatic and upland varieties is recognised in most rice-growing countries, but Kikkawa points out that in Japan some of the so-called upland rices grow and yield better in flooded fields than in ordinary fields; on the other hand, there are some Indian lowland forms that only need flooding during the germinating period; hence it is impossible to draw a hard and fast line separating these two groups. It is probable, however, that the true upland rices are derived from distinct species that have their natural habitat in mountain regions, such as *Oryza granulata*, Nees, and *O. latifolia*, Desv.; but as the upland forms have no distinctive morphological characters their origin is somewhat difficult to account for. Watt considers they have descended from the variety of *O. sativa* known as *abuensis*, which occurs wild on Mount Abu, Rajputana.

The grouping of the varieties into early and late kinds is also a familiar classification for practical purposes in all rice-growing countries. Where climatic conditions are favourable, and the necessary water supply is available, it is possible to raise several crops during the year, and to suit the local conditions that prevail at different periods special varieties of rice have been evolved. Thus in some parts of India five distinct seasonal groups are recognised; they are:

	Sown.	Harvested.
1. "Aus" or early autumn rice .	April-May	July-September
2. "Aman" or winter rice . .	May	November
3. "Boro" (kharif) or autumn rice .	June-July	September-October
4. "Boro" (rabi) or spring rice .	October-November	May
5. "Raydra"	December	September-October

In Siam there are two seasonal groups, viz.:

	Sown.	Harvested.
1. "Khao bao" . .	January-February	May-June
2. "Khao nak" . .	June-July	December-January

In Japan the time of sowing varies with the district, and may differ according to variety, but in most cases all varieties in one district are sown at the same time. The early varieties ripen in from four to five and a half months, the medium varieties in from five to six months, and the late varieties in from five and a half to six and three-quarter months. In Burma the following groups of varieties are known: "Kaukkyi," which ripen in five to five and a half months, and are harvested in January; "Kauklab," ripening in four to four and a half months, and harvested in December; and "Kaukyin," which take only three months to ripen and are harvested in November. In most of the rice-producing countries similar groups of varieties are grown. The term "giant rice" is proposed by Kikkawa for certain forms that grow beyond the normal height of ordinary rice, which is usually about 3 ft., and seldom exceeds 6 ft. In Siam and certain parts of India the stems of "giant rice" have been known to reach a length of from 10 to 15 ft. As they seem to possess the property of growing taller as the water rises, these "giant rices" have their value in districts liable to flooding, and where the depth of the water cannot be controlled.

Fresh water is required for most cultivated rices, but there are a few varieties, known as "salt rices," that will grow in situations that are liable to be flooded with sea-water. Certain rices of the Bombay Presidency and of the Philippines belong to this category, and it would appear that some of the Egyptian varieties are also able to resist the action of salt in the soil, as rice is one of the crops recommended for cleansing salt land in Egypt.

The glutinous properties of some forms of rice grain have been observed from ancient times, and the grouping into glutinous and non-glutinous varieties is well understood. There are, however, few striking morphological characters to distinguish the plants that yield these two kinds of grain, except that the glutinous varieties are said to produce more tender leaves and stems than the non-glutinous kinds. The grain of glutinous rice is readily distinguished, when ripe and well dried, owing to its opaque, chalky appearance, as against the wax-like, semi-translucent grain of the non-glutinous rice; when steamed the former becomes transparent and sticky. Rice obtained from the "Kaukyin" varieties of Burma is said to be so glutinous that it will not stand the boiling required by ordinary rice, and is used for making various kinds of sweetmeats. In China only 20 to 30 per cent. of the total amount of rice cultivated is glutinous. It is occasionally cooked and eaten as a change from ordinary rice, the common method of preparation being to roast the grain after it has been steamed to form a kind of "popped corn."

Hooper states (*Agric. Ledger*, 1908–9, No. 5, p. 75) that the glutinous property is probably dependent solely on the carbohydrate constituents of the grain. According to J. Shimoyama (quoted by Kikkawa, *loc. cit.*) the endosperm of glutinous rice contains only a small amount of common starch, with a small percentage of soluble starch and dextrin as well as some maltose. The grains of both glutinous and non-glutinous rices vary greatly in size, shape, and colour; in some cases only the outer skin is coloured, in others the grain is coloured throughout.

Climatic Conditions and Soil Requirements

Rice is naturally a tropical plant, but under cultivation it grows well in sub-tropical regions, although in such localities it requires a longer period for development. The principal rice-producing areas of the world are situated within a zone that extends as far as 45° north latitude in some parts of the Old World (*e.g.* valley of the Po river, Italy), but in the United States of North America is some 10° farther south. In the southern hemisphere, with a few exceptions, the zone does not extend far south of the Tropic of Capricorn. For its successful cultivation rice requires full exposure to bright sunshine, an average day temperature of above 70° F., with a warm night temperature and a heavy rainfall, or a supply of fresh water sufficient to inundate the soil during the period of growth. It is in this last-named requirement that aquatic or swamp rice differs from all other cultivated cereals. The upland varieties of rice need no more soil moisture than ordinary cereal crops, provided the atmosphere is humid ; but these varieties are grown on a much smaller scale than are the aquatic kinds. Within the zone above mentioned, whenever fresh water can be economically applied to the land, rice can usually be grown as a profitable crop. For the most part, the water necessary for flooding the fields is supplied and controlled by artificial systems of irrigation, and only in certain districts, such as, for instance, the delta zone in Burma and parts of Siam, is the rainfall sufficient to inundate the fields without the help of artificial irrigation. In Eastern countries there are numerous contrivances of a primitive nature, usually involving a large amount of manual labour, for raising the water for irrigating rice fields ; but in the United States of North America, where labour is expensive, and rice is cultivated by modern methods, a large part of the water supply is obtained from Artesian wells, and is raised to the necessary level by means of power-driven pumps.

In respect of soil, rice shows great adaptability, provided inundation is possible during the period of growth. The soil most generally in favour is a rich clay-loam, overlying a subsoil of stiff clay, as such a soil will retain surface water even when situated at a considerable altitude. Rice can, however, be grown on a variety of soils of a lighter character if they are sufficiently low-lying to admit of being flooded and of retaining surface water. Although flooded fields are essential to the growth of lowland rice, good drainage is also necessary, as the complete withdrawal of the water prior to the ripening period provides the conditions most favourable to the proper maturing of the crop. Good drainage also allows of the more thorough cultivation of the soil and permits of its becoming sufficiently firm to support the heavy machinery that under modern methods of rice cultivation is now employed for harvesting the crop. Moreover, where the land is sufficiently drained, crop rotation can be practised, to the great benefit of the rice. In Japan, for example, naked barley and wheat are grown after rice as cold-season crops, whilst in Java rice is grown in rotation with maize, ground nuts, soy beans and other legumes, capsicums, sweet potatoes, millets, and tobacco (cf. this BULLETIN, 1912, **10**, 257). If possible, the land chosen for rice culture should be level, with sufficient slope to admit of ready drainage. On such land it is possible to maintain a fairly uniform depth of surface water, and this conduces to the regular maturing of the crop. Land of uneven contour requires more elaborate banking to form level plots or fields on which surface water will stand at an even depth, and this naturally involves more labour and adds to the cost of production.

Seed Selection

It is important that the grain intended for sowing should be carefully selected with a view to securing seed of high germinative power, true to type and free from red grains. Light grains, which usually fail to germinate, may be eliminated from grains intended for sowing by winnowing or, more effectively, by floating off in salt water; the latter being the method commonly practised in Japan. To keep the grain true to type it is advisable to collect separately, previous to harvest, the finest heads from the best yielding plants of the particular variety found to be the best suited to the locality, and to reserve the grain obtained from these for sowing purposes. The crop obtained from seeds so selected should be subjected to a similar process of selection during subsequent harvests until the type has become "fixed." The mixing of seed intended for sowing is strongly deprecated, as it is probably due to this practice and to the absence of any selective methods that the quality of rice has undergone the deterioration which is said to have taken place during recent years in some rice-producing countries. A recent study of the varieties of rice grown in Lower Bengal has shown that although rice is normally self-fertilised, cross-fertilisation may occasionally take place between adjacent plants through the agency of the wind. So long as all the plants in a plot are true to type, there is no risk of contamination from cross-fertilisation, but should the seed used for sowing be mixed, it would result in reducing a variety to a number of splitting types in a few years (cf. *Mem. Dept. Agric. India, Bot. Ser.* 1913, **6**, No. 1). The elimination of red grains is important, if the crop is intended for export, as the presence of red grains in samples of milled "white" rice lowers the commercial value of the latter considerably, and there are no methods of milling by which red grains can be separated from white when the two kinds are mixed together. For milling purposes the grain should be regular in size, large and heavy, long and cylindrical in shape, as such kinds are less liable to get broken during the milling processes than are flat or "turtle-grained" varieties. A small embryo or "germ," a thin, awnless husk, and a hard, translucent kernel capable of taking a high polish are other desirable qualities. The nitrogenous qualities and weight of the grain may be improved by cultivation, by the addition of suitable manures to the soil, or by growing the grain on virgin land. The breaking of the grain is frequently due to careless harvesting, and is not in all cases an inherent defect in the variety of rice.

An increased yield may sometimes be obtained by sowing seed from some other locality. Before this is done on a large scale, however, it is advisable to test the new variety by growing on an experimental plot, otherwise loss may result. Obviously a variety requiring six months to mature cannot succeed where the climatic conditions and water supply are only suitable for a variety ripening in from three to four months, and there are other less striking peculiarities that require to be ascertained experimentally before changing seed on a large scale.

Manures

Owing to the saturated condition of the soil essential to the growth of lowland rice, the selection of a suitable manure for this crop is a matter of some difficulty. Where the land is naturally flooded or, in some cases, where river water is used for irrigation, a layer of silt is deposited by the water standing on the soil, which is to a varying extent enriched thereby, and little manuring is required. In common with other cereal crops, rice withdraws nitrogen, phosphoric acid, and potash from the soil, and these constituents require to be present in manures intended to restore fertility to rice lands. Very little systematic manuring is done in rice-producing countries, but recent experiments in India and elsewhere have shown that the yield can be increased considerably by the judicious use of suitable manures. On the other hand, if the crop is unduly stimulated it is liable to produce a rank growth of straw, accompanied by a poor yield of grain. Experiments on the Central Farms, Coimbatore, have shown that bulky organic manures applied to rice fields give better results than manures of similar value but containing little organic matter. In Oriental countries where manuring is practised, the manures most in favour for rice are green manures, oil-cake, farmyard manure, night soil, and fish manure, all of which contain a considerable amount of organic matter that on decomposing serves to increase the amount of humus in the soil and to improve its physical properties. Nitrates are unsuitable as rice manures, as they are soluble in water and liable to be washed away, whereas compounds that yield ammonia in rice lands are valuable, as the rice plant readily absorbs ammonia, which, although soluble in water, is retained by the soil to a much greater extent than are nitrates. Recent experiments with cyanamide, which yields ammonia in rice soils, have given promising results, and it may possibly prove useful for mixing with low-grade poonac or other organic manures deficient in nitrogen.

Where rotation of crops is practicable, organic manures are best applied to the crops preceding rice, but if this is not possible it is advisable to apply them to the fields about a month before transplanting the rice, as if applied just previous to transplanting the products of decomposition may prove detrimental to the young plants.

The following leguminous plants have given good results as green manures in India: "daincha" (*Sesbania aculeata*), sunn-hemp (*Crotalaria juncea*), wild indigo (*Tephrosia purpurea*), and green gram (*Phaseolus Mungo*). Under favourable conditions daincha will grow to a height of 8 ft., and 1 acre will yield sufficient material to manure 4 acres of rice land. The other plants mentioned are of lower growth, and are best grown on the land and ploughed in. In Japan the most favoured green manures for rice are the soy bean (*Glycine hispida*) and "genge" (*Astragalus sinicus*). These and other leguminous plants add nitrogen to the soil, and on decomposition return to the soil the phosphoric acid and potash they had absorbed. Even more valuable as green manures are green leaves collected in forests or waste places, as they add phosphoric acid and potash to the soil, in addition to nitrogen and humus. The manures above mentioned are chiefly valuable for supplying nitrogen to the soil, but they may be rendered more effective by the addition of phosphatic manures. Of these the most suitable for rice are superphosphate and bone-meal, both of which give quick results in rice soils. It is seldom necessary to add potash manures to rice land, especially if the stubble or straw is burned on the soil or turned in when ploughing is done. Where soils are found to be actually deficient in potash, it may be added in the form of wood-ashes or potassium sulphate.

The kind of manure applied will naturally depend to a large extent on local circumstances as regards availability and cost of transport, and the peculiarities of the particular soil to be dealt with. As a guide to mixtures that have given good results when used experimentally, the following may be quoted: A leguminous green-manure crop plus 112 lb. per acre of superphosphate; bone-meal 240 lb. plus saltpetre (nitrate of soda) 60 lb. per acre; fish manure 560 lb. per acre, plus sulphate of potash or wood-ashes on soils deficient in potash; castor-oil cake 400 lb. per acre, either alone or with the addition of superphosphate; green leaves alone 4,000 lb. per acre.

ORIENTAL METHODS OF RICE CULTIVATION

The general methods of cultivating rice are the same in nearly all the rice-growing countries of the East, although they differ in detail according to local circumstances. In eastern and south-eastern Asia the first condition of rice culture, in its early stages, is the utilisation of the rainy season which follows the change of monsoon in spring.

Where the rainfall is not sufficient to supply the requisite amount of moisture, artificial irrigation has to be resorted to. The native practice is to utilise any stream or river that may be available for this purpose, and, where necessary, canals are formed to convey the water to the rice fields. Frequently a stream at the head of a valley or on a hill-side is utilised for this purpose, the hill-side or sloping valley being terraced or banked up in order to form level plots that will retain surface water. Terraced hill-sides are characteristic features of most of the rice-growing countries of the East; they are usually very ancient, and represent a large expenditure of human labour. In such situations the rice fields usually consist of small plots of one-tenth to one-eighth of an acre or less in extent, of irregular outline, each surrounded by a mud dyke or "bund" to retain the water. The first cost of putting up these bunds is heavy, but when once formed they last for many years with occasional repairs. The cultivation of such small plots entails a large amount of manual labour, as from their situation and form it is impossible to employ machinery, except the primitive native ploughs and levelling implements. On low-lying, level lands the fields are larger in extent and more economical to cultivate.

Seed-bed.—As most of the aquatic or swamp rice is transplanted, cultural operations commence with the seed-bed, or nursery, where the young plants are raised. To form the nursery, the best field, or portion of a field, possessed by the cultivator is usually selected, situated where it can be readily irrigated. Usually from about one-twentieth to one-tenth of the area to be planted is required to form the seed-bed.

The soil of the selected site is first softened by rain or by being flooded with water, and is then ploughed with a native plough several times in cross directions, or turned with the mamoti and puddled by treading, so that the surface soil to a depth of about 3 in. is reduced to a soft mud, on which the seed is sown broadcast. The soil of the nursery is usually enriched by the application of manure before ploughing. In Japan a favourite manure for this purpose is canal mud or ashes and night soil; in Burma it consists either of cow-dung or paddy husks applied to the soil about a month before cultivation commences. In Western India the seed-bed is prepared by the "rab" system. This consists in burning cow-dung, branches of trees and shrubs, grass and other combustible material on the soil, after which the seed is sown in the ashes and ploughed in as soon as the first rains fall. The seedlings from beds prepared by the rab process are much stronger, and succeed better when transplanted than those raised in the ordinary way. The efficiency of this process is due to two causes—(1) the heating of the soil and (2) the manurial effect of the ash and other material left on the land after burning (cf. *Mem. Dept. Agric. India*, *Chem. Ser.*, 1912, **2**, No. 3).

The seed-bed is flooded to a depth of about 3 in., and is kept saturated by artificial irrigation should the rains not be sufficient. When the rains are late, and water for irrigating the seed-bed is not available, the seed is sometimes sprouted before being sown in order to expedite growth. This is effected by soaking the seed in water for about twenty-four hours, and then spreading it on bamboo trays shaded from the sun by leaves. Germination takes place in a few days, and it is then ready for sowing. Care is required in sowing sprouted seed, as the delicate shoots are liable to receive injury from handling.

In the Laguna Province of the Philippines the natives spread the seed of early varieties of rice, after being soaked, on banana leaves, which are then sunk into the soft mud of the seed-bed only just sufficiently deep to cover the seeds. In from twelve to fifteen days from sowing the seedlings are 10 cm. (4 in.) high, and the roots have formed a thick mat over the banana leaves, but have not penetrated to the soil below. They are readily removed from the seed-bed without injury to the roots, and are transplanted when only from ten to fifteen days old.

In Java, soil of only average fertility is chosen for the seed-bed, as experience has shown that seedlings from rich beds receive a check, and grow less satisfactorily after being transplanted to a less fertile soil. Great importance is also attached to what are known as "dry" seed-beds, which, in the absence of rain, are kept only just sufficiently moist to maintain a slow growth of the seedlings. In such beds seedlings may remain for as long as a hundred days, and can then be transplanted without harm. In districts dependent entirely upon rainfall, transplanting has often to be delayed for want of rain, and in such localities "dry" seed-beds are particularly valuable. Before lifting seedlings from such beds a thorough soaking of the soil is, of course, necessary, so that the roots may be removed from the soil without receiving injury.

Preparation of the Soil.—During the time the seed is germinating in the seed-beds and the young plants are becoming sufficiently large to transplant, the preparation of the rice fields takes place. The soil is first softened by rain, or by irrigation if the rains have not commenced, and then subjected to shallow ploughing. Usually a rank growth of grass and weeds appears as soon as the rains commence, and this has to be cut down before ploughing takes place. A hand machine, constructed on the principle of the ordinary lawn-mower, has recently been introduced into Burma for this purpose. Several ploughings in different directions are given, and the field is then allowed to stand for a week or so to become dry. It is then flooded, and a further ploughing and harrowing under water takes place to produce a soft puddle, into which the young rice plants can be readily inserted. Motors are now being used for ploughing in Siam. The motors are oil-driven traction engines which have been adapted for ploughing, and are found to work well and give little trouble. The best motors, of 15 horse-power, are employed to pull heavy disk harrows, and are capable of ploughing 2½ acres of stiff clay land per day, to a depth of about 4 in. Smaller motors of 5 horse-power are used to pull two-furrow share ploughs. The cost of employing these machines is found to be much cheaper than bullock ploughing, and, it is anticipated, will be further reduced when specially constructed motors become available.

Transplanting.—In from thirty to forty days from the time of sowing, the seedlings are ready to be transferred from the seed-bed to the fields. They are then from 1 to 1½ ft. high. They are lifted from the seed-bed and made up into bundles, each comprising about 1,000 seedlings, which are conveyed to the fields and deposited at intervals convenient for the workers. If strong and well grown, a portion of the upper leaves is removed from the young plants, which has the effect of limiting transpiration until new roots have formed in the soil. The planting is largely done by women, who walk backwards and insert the plants, usually three to five or more together, in the soft soil, at a distance apart of from 6 to 8 in. Recent experiments in Bengal and in Japan have shown that as good results are obtained from planting the seedlings singly as from planting in clumps. This fact is important, as it follows that a great saving in seed would be effected were single planting generally adopted. Single planting would, however, necessitate much thinner sowing in the seed-bed, to enable the plants to be separated without injury to the roots, as under the present system of raising seedlings the roots are usually matted together.

Broadcast sowing is sometimes adopted in lieu of the transplanting process, especially in cases where the rains are late and where irrigation by artificial means is not practicable. This is a wasteful method, and does not give such good results as transplanting, but it entails less labour. Some of the seasonal rice crops of India, which follow other crops, are broadcasted. In this latter case the land is moistened and ploughed several times, the seed is sown in the moist soil, and sufficient water is applied to cause the seed to germinate, after which the soil is kept moist by irrigation during the growing season.

Irrigation.—From the time the rice is transplanted up to about a fortnight or three weeks before harvest the soil of the rice fields is kept submerged. The amount of water in the fields is carefully regulated, more or less being admitted according as the weather is warm or cool, dry or humid, in order to maintain a certain temperature around the plants. The water is withdrawn from the fields before ripening takes place, otherwise the grain does not acquire the right degree of hardness, and is frequently changed during the growing season in order to prevent stagnation and to check insect pests.

Weeding.—Weeds are usually troublesome in rice fields and require attention throughout the growing season, especially during the early stages. Hand-weeding is usually practised, and where broadcast sowing has been adopted this is the only method, but when planted in rows, hoes are sometimes employed. The water is usually wholly or partly withdrawn during the weeding process, and this checks the further development of young and succulent weeds which are allowed to remain between the rice plants after being pulled up, but the tougher weeds and grasses are usually removed from the fields and heaped on the banks to decay.

Harvesting.—The water supply is gradually diminished after flowering and is stopped altogether when full growth has been attained and the stems begin to lose their green colour. In Burma, before the rice is cut, the stems are turned in one direction by means of a long bamboo pole, and as the sickle is the principal implement employed for reaping the rice crop, this greatly facilitates harvesting operations.

When harvesting is done with the sickle, the straw is usually cut about the middle, so that a long stubble is left in the field. The heads of rice are tied up into small bundles which are placed on the stubble to "cure," and in about ten days these are ready for thrashing. If circumstances prevent the crop being thrashed at once, it is made up into small stacks. In some countries (Java, for instance) the ears are cut separately with a small knife and tied into bunches which are removed from the field to a favourable situation for drying before being thrashed. Thrashing is usually done by treading out with bullocks, by flailing or by beating the heads on a sloping plank of wood. The dust and other refuse is separated from the grain by primitive methods of winnowing.

METHODS OF CULTIVATION IN THE UNITED STATES

In the United States of North America, rice cultivation is limited to the South Atlantic and Gulf States, where in some districts it is the principal cereal crop. Since its introduction in 1694 rice has been cultivated on an increasingly large scale until in 1912 some 723,000 acres of rice were harvested and the production amounted to 25,054,000 bushels. The principal producing States are Louisiana, Texas, and Arkansas, the first-named being the most important. The great development of rice culture in Louisiana is largely due to the opening up of prairie land in the south-west part of the State, and to the adoption of a system of irrigation and culture which has made it possible to utilise modern machinery for the crop. The principal varieties of lowland rice cultivated are, the "gold seed" of the Carolinas, so called from the colour of the husk when ripe; the Honduras and Japan varieties. The "gold seed" variety takes high rank amongst cultivated rices of the world for quality of grain and for yield. The Honduras variety, originally introduced from Mexico, is similar in form of grain and habit of growth to the "gold seed" variety, but the quality is not so good. The Japan varieties were introduced on account of their superior milling qualities, one of them, known as "kiushu," yielding from 90 to 95 per cent. of "head-rice" on milling as against an average of about 40 per cent. by the Honduras and Carolina varieties.

Soils.—There are four principal kinds of rice land in the United States: they are (1) *delta lands* situated sufficiently remote from the sea to be free from flooding by salt water; (2) *inland marshes*, that can be conveniently drained and economically irrigated; (3) *alluvial lands* bordering fresh-water rivers; and (4) *prairie lands*, practically level areas that can be converted into rice lands with comparatively little expense.

The type of soil most favoured in the United States is a rich clay-loam, containing about 50 per cent. of clay. The rich drift soils of Louisiana and Texas prairies have a clay subsoil that is retentive of the water essential to the rice crop, and some of these soils are so stiff that they cannot be ploughed until softened by flooding. When properly drained they admit of the complete withdrawal of the surface water for ripening the crop, after which they become sufficiently firm to allow of the use of a team of horses and heavy machines for harvesting. Alluvial lands, such as those along the Mississippi river in Louisiana, which have no hard, compact subsoil, cannot be drained in the same way and will not admit of the use of heavy machinery.

Gravelly and sandy soils have not, as a rule, been found suitable for the rice crop, as their physical properties will not allow them to retain the necessary amount of surface water; peaty soils have also been found unsuitable.

Preparation of the Soil.—This consists in spring ploughing shortly before planting time. Shallow ploughing to a depth of not more than 3 in. is practised by some growers on the grounds that the rice plant is surface-rooting and therefore does not require a deep-rooting medium, and also that deep ploughing renders the soil too porous. Deeper ploughing is, however, practised in many cases with good results. Where the subsoil is alkaline, deep ploughing is done in the autumn, so that harmful salts are washed away from the surface by the winter rains. The surface soil is brought to a good state of tilth after ploughing by the use of the disk harrow and by rolling. Good drainage is provided by means of open ditches, which in all cases are made deeper than the furrows, and the main drains are at least 3 ft. deep.

Sowing.—In most cases sowing is done by April 20, but the season varies according to locality, and may be as late as the middle of May or as early as the middle of March. It usually takes place as early as possible after the spring ploughing is completed. The amount sown per acre varies from 55–80 lb., according to the variety and method of sowing. The grain is sown either broadcast or in drills, the latter method giving the best results. After sowing the land is rolled and harrowed, and sufficient water is admitted from the irrigation supply to saturate the soil and ensure the germination of the seed. In the event of the soil being sufficiently moist to effect germination, the irrigation at this period is omitted. As in the East, the seed is sometimes sprouted by soaking it in water before sowing—a practise not recommended as, unless the soil in which sprouted seed is sown is sufficiently moist to continue the growth, failure frequently results.

Flooding.—The practice varies considerably in different localities and is naturally influenced by the rainfall. Generally it is as follows: water is admitted to the fields as soon as the seedlings are a few inches above ground, and the depth of the standing water is increased as rapidly as growth permits until it is sufficient to destroy weeds. As far as possible a uniform depth over the whole field is maintained, as this conduces to the uniform maturing of the crop, and there is a regular intake and overflow of water in order to prevent stagnation. Water is frequently kept on the fields at a greater depth than is essential for the welfare of the rice crop in order to keep down weeds, but it has been found that "tillering" is greatly encouraged, and the yield thereby largely increased, by keeping the soil saturated with water but not allowing sufficient to stand on the surface until after the plants have fully "tillered."

In South Carolina the practice above described is somewhat modified. The sowing is made in well pulverised soil in trenches 12 in. apart and from 2 to 3 in. deep, opened by 4 in. hoes at right-angles to the drains. The grain is usually covered with soil, but in some cases the seed is dipped in clayed water before sowing, and is left uncovered, sufficient clay adhering to prevent it floating away. The water is admitted to the fields as soon as sowing is completed, and is allowed to stand for from four to six days until the grain has sprouted, when it is withdrawn. A second watering is given when the blade is a few inches high, and this is also withdrawn. A third watering is given after the seedlings have formed two leaves; at first the water is allowed to cover the plants completely, being generally from 10 to 12 in. deep, but this depth is reduced until it stands at about 6 in., at which it is kept for from 20 to 30 days, when it is withdrawn and the fields allowed to become dry. As soon as the soil is in a suitable condition it is hoed and weeds removed, and after the hoeing it remains without irrigation until "jointing" commences. A second hoeing is then given, after which water is again let on and is allowed to remain until about eight days before harvest, being changed at least once a week to prevent stagnation.

Harvesting.—Rice is cut when the straw has just commenced to turn yellow, and is not allowed to stand until the stems have turned yellow to the top. Where fields are of a sufficiently large area and the soil of the requisite firmness to admit of their use, modern reaping machines or self-binders are employed to harvest the crop. Where the use of machines is not practicable the sickle is usually employed.

The straw is cut at about 6 to 12 in. from the ground, and the heads of rice are laid on the stubble to prevent contact with the wet soil. After remaining for a day to "cure" they are made up into bundles and stood in small stacks or "shocks." The "shocking" is done on dry ground, and care is taken to prevent exposure of the heads of rice to sun or rain by capping the shock with bundles, the heads of which are placed on the north side. Exposure to sun and rain is held responsible for sun-cracked kernels which, when present in a sample, greatly reduce its milling qualities and consequently its market value. Judgment is required to determine when the "curing" is complete, but in favourable weather a period of from 10 to 12 days after cutting suffices to harden the grain and dry the straw. Stacking is sometimes practised, but is not considered essential, and the grain is usually thrashed after being dried in the shock.

Thrashing.—This is now largely done by the use of the steam thrasher, as in the case of other cereals. Care is essential, in dealing with rice, to prevent breakage of the grain. Before being put up into sacks the grain is spread upon a floor and dried, as if sacked whilst damp the colour of the grain and its milling qualities deteriorate.

The average yield is from 8 to 12 barrels = 1,296 to 1,944 lb. of "rough rice" per acre, but on good lands properly managed the yield may be much higher, as on the lowlands of the Mississippi, where 30 barrels (= 4,860 lb.) per acre have been recorded.

THE CULTIVATION OF UPLAND OR HILL RICE

As already pointed out, the upland and lowland forms of cultivated rice tend to merge into each other, and no sharp line of distinction can be drawn between them (see p. 636); the extreme forms of each kind are, however, quite distinct so far as cultural requirements are concerned, and whilst standing surface water is essential to the development of typical lowland rice it is unnecessary and even harmful to the extreme forms of upland rice. The cultivation of the latter is confined chiefly to hilly districts which cannot be artificially irrigated, and which in consequence are unsuited to lowland rice. Comparatively little cultivation is required, transplanting being unnecessary, and the natural rainfall affords the requisite amount of moisture.

Usually only a short period is required to mature the crop, the exact length of time necessary depending on the particular variety of rice grown and, to a large extent, on the duration of the rainy season.

The crop is therefore one which can be grown as a catch-crop on new plantations of perennial plants, or in rotation with other crops, and is worthy of more attention than it at present receives, especially in districts where a local demand for rice exists.

The success of the crop depends chiefly on the thorough preparation of the land, as this not only destroys weeds, but produces a fine surface tilth which serves as a suitable seed-bed for the grain and also tends to check the evaporation of soil-moisture. Soils of a lighter character than those required by lowland rice are preferable, and if it be virgin land a shallow ploughing is the only preparation required, but if the land has been cropped for several years deeper ploughing is essential in order to provide a more extensive rooting medium. As the seed is sown on the field and not on a seed-bed, it is important that grain of high germinative power should be selected for sowing, otherwise the stand will be thin and the crop proportionately scanty. For this reason it is advisable to test the vitality of the grain intended for planting, and to regulate the thickness of the sowing according as the percentage of germinated seeds is high or low.

The cultivation of upland rice is carried on by the natives in nearly all rice-growing countries, but on a much smaller scale than in the case of lowland rice. Forest clearings are usually planted with this crop and abandoned after the first harvest, but as this is a wasteful system, destructive to the forests, it is now discouraged in most countries, and in some cases it is forbidden. The native methods of cultivation as practised in the Philippine Islands are described in the *Philippine Agric. Review* (1910, **3**, 632), and these may be taken as typical of the general practice. Two methods are practised in the Philippines known locally as the "caiñgin" and the "sábog" methods. The caiñgin method consists in clearing a portion of the forest of shrubs and small trees and burning them on the ground, prior to the rainy season, leaving the stumps of larger trees standing. The area thus cleared is planted at the commencement of the rainy season. The planting holes are made by men who place themselves side by side about 3 ft. apart and walk backwards, and, by means of pointed sticks 1 to 1½ in. in diameter, make shallow holes in the ground, from 4 to 8 in. apart, to receive the seed. The seed is sown by women or children, who walk facing the men, and place from 4 to 20 grains in each hole. From 4 to 7 grains, in holes 6 in. apart, usually suffice. The right hand is used for handling the grain, and with the left the holes are filled in with soil. In some cases the filling in is done by a third party of workers who follow the sowers and cover the seed by brushing soil into the holes.

By the sábog method the ground is ploughed once during the dry season, and again at the commencement of the rainy season, after which it is harrowed and the seed sown broadcast. A light harrowing is given after sowing, in order to cover the seed. Occasionally the seed is sown in drills instead of broadcast, in which case the sower follows the plough and places from 5 to 20 grains at intervals of from 4 to 8 in. along the furrow, covering them with soil by the foot, or the seed may be evenly distributed along the furrows instead of in "hills," and covered by lightly harrowing the soil.

The rate of seeding is about 58 lb. per acre. The average yield is usually not more than half that from transplanted lowland rice, but on virgin lands, if the rains are favourable, heavier yields are frequently obtained.

During the years 1909 and 1910 the Philippine Islands Bureau of Agriculture made trials of some 458 native varieties of upland rice. Of this number only twenty-five are recommended for general planting. These are non-bearded kinds with white, non-glutinous grains; the length of time they required to attain maturity varied from 126 to 141 days, and the yield from 2,378 to 4,064 lb. per acre. In these trials the average yield was higher than for lowland varieties, but the trials covered a period of only two years, and both seasons were favourable to the crops (cf. *Bulletin* No. 22, 1912, *Philippine Islands Bureau of Agriculture*).

Upland rice has been successfully grown in the Logan district of Queensland, with a rainfall of between 20 and 30 in. during the growing season. The variety found best adapted to this locality is known as "White Java." This grows to a height of from 4 to 6 ft., and produces good crops of fairly plump grain, of good length and quality. The land is prepared as for an ordinary cereal crop, by ploughing and harrowing, to produce a fine surface tilth. The method of planting found to give the best results consists in sowing with an automatic seeder, in drills 2 ft. 6 in. to 3 ft. apart, with a spacing of 10 to 12 in. in the rows. The method requires 35 to 40 lb. of seed per acre as against about 60 lb. for broadcast sowing. The wide spacing between the rows permits of the use of the hoe or cultivator to remove weeds during the early stages of growth; it also encourages "tillering," and as many as thirty or forty heads of grain have been obtained from a single seed.

(To be continued.)

COTTON CULTIVATION IN NORTHERN NIGERIA

An account of the cotton industry of Northern Nigeria was published recently in this Bulletin (1913, **11**, 70), together with the results of examination at the Imperial Institute of samples of cotton grown in the Protectorate. Further information on this subject has been made known by the Director of Agriculture in the form of a Report on Cotton Cultivation in Northern Nigeria for the half-year ending December 31, 1912. As this Report is of considerable interest, it has been considered desirable to summarise it in this Bulletin.

The period under review practically comprises the cotton-growing season of Northern Nigeria, very little seed being sown before the former date, and practically no growth taking place after the latter, though the maturing of the bolls may continue some six weeks longer under favourable conditions. In spite of this, however, it would be wrong to suppose that the weather prior to July 1 has little or no influence on the cotton crop, for it is upon the earlier rains that the cereal crops (chiefly guinea corn and millet) depend for a satisfactory start, and not until the peasant sees the success of his staple food crops assured can he afford to expend labour on cotton.

In considering cotton production in Northern Nigeria, it must never be forgotten that the greater part of the Protectorate is faced with the problem of an annual drought of about five months' duration, extending as a rule from November to March; during the remaining seven months the food supplies of the year have to be raised, and the law of self-preservation naturally makes this the work of prime importance. This being so, it is difficult to see how cotton cultivation can ever occupy anything but a position of quite secondary importance.

The present season is a case in point. Over considerable areas the earlier rains were later and lighter than usual, with the result that agricultural operations were unduly delayed. Fortunately the later rains were generally plentiful, work went on apace, and the consequence was that corn crops generally were well up to the average.

The same remarks apply to cotton which was sown during the first half of July. This unfortunately was seldom accomplished, however, large areas being sown in August; some plots in the neighbourhood of Zaria did not even receive their seed before the third week in September. One of these last-named plots was visited, and, as might be anticipated, in view of the fact that rain does not generally fall in this locality later than October, it was found that the plants had withered when some few inches high, not producing even a flower. Every gradation exists, from late-sown plots, such as the one described, up to the earliest sown, which present in most cases a very creditable appearance.

The native, of course, understands quite well that the later-sown cotton will not yield so heavily as that sown at an earlier date, but, as previously pointed out, the cultivator can but wait on the weather, and live in hopes that the rains may last long enough to give him at least some return for his labour.

From what has been said already it is clear therefore that, at any rate so far as the Northern Provinces are concerned, "early maturity" is a most important factor in the selection of a variety for general cultivation.

The fact that cotton has been cultivated by the natives of Northern Nigeria from time immemorial has often been quoted as going to prove that the Protectorate is admirably adapted by nature for cotton production, but this line of argument is by no means convincing. Numerous instances exist of commodities being produced in countries ill-adapted for their growth. The question appears to be merely one of supply and demand. In Nigeria a limited demand for raw cotton has existed for centuries at prices bearing little or no relation to those of the European market, the value of cotton at Kano having probably often been twice as great as at Liverpool, and cotton has been grown to meet this local demand.

There is every reason to hope that, since the British Cotton Growing Association has now created an unlimited demand for raw cotton in Nigeria, the country may respond by increased production, but any such production will be achieved, not with the assistance of a fertile soil (see p. 626), but in spite of the generally prevailing very light sandy loam, which is incapable for the most part of producing heavy cotton crops without manure.

The Director of Agriculture spent six months touring in the principal cotton-producing districts of Zaria and also of Ilorin, studying, among other things, the presumably indigenous varieties of cotton. This inquiry has led to extremely interesting results, establishing the fact that there are at least four distinct species at present in cultivation. These include:

Gossypium peruvianum. Ilorin cotton with green stem and leaf veins. Zaria cotton with red stem and leaf veins.

G. punctatum. Kano annual cotton.

G. obtusifolium, Roxb. var. *africana.* Kano perennial.

G. arboreum var. *sanguinea.* Tree cotton, rather uncommon, with dark crimson flower, grown in compounds in villages, and often used for native medicine; observed in Ilorin, Bida, and Soba.

G. peruvianum is, speaking generally, by far the commonest type, and probably 95 per cent. of the Nigerian cotton handled by the British Cotton Growing Association is derived from this species. The Ilorin variety of this species, characterised by green leaf veins, required, as would be expected, a longer season to reach maturity than the Zaria variety, which belongs to a drier zone. Neither of these, however, matures so rapidly as *G. punctatum*, which is grown in the still drier region of Kano as an annual with great success.

G. obtusifolium is grown as a perennial, and is adapted to climates with a rainfall so scanty as to render the growth of an annual cotton too hazardous an undertaking. The plant was observed in the region of Lake Rudolph, and there is reason to believe that it is to be found throughout the drier parts of the southern Sudan.

During the past season, plots of the Zaria variety of *G. peruvianum* were grown alongside the Kano cotton (*G. punctatum*). Though both plots were sown on the same day, namely July 3, the picking of the former had not been begun on December 31, whereas the harvesting of the latter was practically complete on that date. In view of this evidence, the Director of Agriculture would be strongly opposed to distributing seed from the Zaria ginnery in Kano Province during the coming season, except perhaps on the southern border adjoining Zaria, where the Zaria variety of cotton is commonly cultivated.

The Director of Agriculture summarises his impressions as to the present position of cotton cultivation in Northern Nigeria as follows:

"In the first place, I am very favourably impressed by the area devoted to cotton and by the knowledge of the crop which the natives already possess. The general adoption of ridge cultivation and the time devoted to hand-hoeing are almost comparable with Egyptian methods. These remarks, however, do not apply in the Ilorin district, where cotton is almost universally grown on mounds in conjunction with yams, and often indeed with maize as well.

"The dry climate, particularly in the north, permits of the staple being gathered in first-rate condition, remarkably free from stained and immature cotton. Unfortunately, the tendency is to leave the cotton on the plants so long that it often falls to the ground, thus picking up particles of earth and other foreign matter, which deteriorate the grade.

"What strikes me perhaps more than anything else is the inferiority of the native cotton (*G. peruvianum*) from a fruiting point of view. The plants produce an abundance of wood, carrying their bolls (unlike *G. punctatum*) almost entirely on the secondary branches. They bear bolls very sparingly, and those which are borne are small and frequently abortive. The bolls are, like the Mitafifi of Egypt, almost invariably three-locked, and the lint also possesses the characteristic creamy colour of that variety, though the intensity of the tint varies considerably in the cotton from different plants, as does the lint, which is generally short and coarse.

"One of the commonest and most obvious errors in cultivation is the leaving of two, three, or even a dozen plants at each place, struggling with one another to secure the available supplies of moisture and plant food which, in the majority of cases, are all too small to develop even one plant to perfection.

"In the riverain provinces the pernicious habit exists of not uprooting old cotton plants, but allowing them to remain over for a second season or to become overgrown with bush, thus providing ideal feeding ground for hosts of insect pests, including stainers and boll-worm. Both of these, but more especially the latter, have done immense damage in the Ilorin Province during the period under review, and urgent measures will have to be adopted to keep them in control. Nothing is at once so practicable and so efficient as clean methods of cultivation, including the uprooting and destruction by fire of the old plants, as well as those of okra and the allied species of *Hibiscus*, as soon as the crop is gathered, thus depriving the insects of their principal host plants."

So far as climate and population are concerned, Northern Nigeria is probably a great deal better equipped for cotton production on a large scale than the majority of British Dependencies. The pack-donkey and pack-ox transport common throughout the Northern Provinces, as well as the innate trading instinct of the Hausas, also offer additional facilities for expansion. But this keen eye to business causes the native, here as elsewhere, to judge cotton entirely on its merits, and where other cultivations prove more profitable, cotton will receive but scant attention. In order to secure a rapid development in the output of cotton from Northern Nigeria every endeavour must be used to make cotton cultivation a more lucrative undertaking. The most obvious way of achieving this end is to establish a variety characterised by early maturity, heavy yield per acre, high ginning percentage, and strong, regular lint at least 1 in. in length. This is the problem which the Agricultural Department has seriously taken in hand.

THE CONVERSION OF LIQUID OILS INTO SOLID FATS

THE essential difference between a liquid oil, such as cotton seed oil, and a solid fat, such as palm oil, is that the oils are composed mainly of olein (a compound of glycerine and oleic acid) whilst the solid fats are largely composed of stearin or palmitin (compounds of glycerine with stearic or palmitic acid). Oleic acid is liquid and yields a liquid glyceride (olein), whilst stearic and palmitic acids are solid and yield solid glycerides (stearin and palmitin). It is obvious that if any simple method of converting oleic acid into palmitic acid or stearic acid could be found, then the commercial manufacture of valuable solid fats from the much less valuable liquid oils should be possible.

This has long been known, and for many years past attempts have been made to devise technical methods for the conversion of liquid oleic acid, and of liquid oils consisting largely of glycerides of oleic and similar unsaturated acids, into solid saturated acids or glycerides, such as stearic acid or stearin, suitable for the manufacture of candles, hard soaps, etc. The technical importance of the problem is at once apparent when it is remembered that large quantities of oleic acid are obtained as a by-product in the manufacture of stearic acid for candles, and "oleins" are similarly obtained as by-products in the removal from oils and fats of "stearins," of high melting point and firm consistence, to be used in the manufacture of margarine, and for other purposes (see this BULLETIN, 1912, **10**, 280).

The liquid oleic acid and "oleins" are of less value than the solid stearic acid and "stearins," and speaking generally most of the liquid vegetable oils of commerce are of much lower value than the solid fats, consequently the possibility of converting liquid oils into solid fats has attracted much attention from chemists and technologists.

Many processes have been proposed for the conversion of oleic acid into solid acid suitable for candle-making, but few appear to have met with industrial success. According to Lewkowitsch (*Chemistry, Technology, and Analysis of Oils, etc.*, vol. ii. (1909), p. 190), the only processes in use in 1909 depended on the treatment of oleic acid with strong sulphuric acid, whereby a partial conversion of oleic acid into hydroxystearic and other solid saturated acids takes place, and the acids are then separated by subsequent distillation. This method has been worked on a large scale. The conversion of liquid unsaturated acids or glycerides into solid saturated compounds is a simple chemical reaction, and consists in reduction with hydrogen, which can in certain cases be carried out readily under laboratory conditions. On a technical scale, however, the process was impracticable until Sabatier and Senderens introduced their method of reducing organic compounds by hydrogen in presence of a catalyst (*i.e.* a substance which facilitates a chemical reaction between other substances, but is not itself affected by the reaction), such as nickel. Soon after the publication of Sabatier and Senderens's early researches, patents were taken out by Le Prince and Sieveke (German Pat. 141,029, Aug. 14, 1902) and Norman (Eng. Pat. 1,515 of 1903), for the conversion of unsaturated acids, or their glycerides, into saturated compounds by treatment with hydrogen in the presence of a catalyst. Since these dates many patents have been taken out for processes of working, machinery, etc., suitable for carrying out the reduction. It is unnecessary to discuss here these patents or the technology of the process, especially as details can be found, by those interested, in the various technical journals, such as the *Journal of the Society of Chemical Industry* (1912, **31**, 1155). The wide applicability of the process, however, and its great importance to all interested in the oil and oil seed trades, render a brief description of the process necessary. Theoretically one molecule of oleic acid combines, on reduction, with one molecule of hydrogen to form one molecule of stearic acid, according to the chemical equation

$$\begin{array}{ccccc} C_{18}H_{34}O_2 & + & H_2 & = & C_{18}H_{36}O_2 \\ \textit{Oleic acid.} & & \textit{Hydrogen.} & & \textit{Stearic acid.} \end{array}$$

Similar reactions take place in the case of other unsaturated glycerides or of other unsaturated acids, such as linoleic and linolenic acids. The conversion of 2,000 lb. of oleic acid would therefore require about 14 lb. or 2,500 cubic ft. of hydrogen gas for its complete conversion into solid stearic acid. The process consists in treating the liquid oil or acid with hydrogen gas in the presence of a catalyst.

Theoretically the quantity of catalyst used is inexhaustible, since, as explained above, it facilitates the reaction but is itself unaffected by it; in practice, however, catalysts lose their activity owing to "poisoning" by impurities. The oil is generally heated, and is brought into ultimate contact with the catalyst either by spraying, by agitating, or by other means, while the hydrogen gas, which must be carefully purified, is generally applied under pressure. Two essentials of the process are an active catalyst and a cheap supply of pure hydrogen. With regard to the catalyst some form of nickel appears to be used most generally, because of its low cost and high efficiency; palladium, in spite of its great initial cost, has received much attention on account of its high efficiency, and other materials, such as platinum, copper, iron, etc., have also been used to a certain extent. The cheap supply of hydrogen is an important problem; at present the processes most favoured are (1) the iron-sponge steam process, in which steam is decomposed by heated iron, hydrogen and iron oxide being formed, the iron being re-generated for use by reduction with water-gas; and (2) electrolysis of water. Of these processes the former is complicated, and most suitable for large plants requiring over 1,000 cubic ft. of hydrogen per hour, while the latter is particularly suited to smaller plants, and in localities where electric power is obtainable at cheap rates. It possesses the further advantage of producing hydrogen of a high degree of purity, while the capacity of the plant can be increased readily by the addition of further generator units. The iron-sponge steam process is being used at large works in England and on the Continent; the electrolytic process is used in America, and a company has been formed to carry on the hydrogenation of whale oil at Fredrikstad in Norway (*Dipl. and Cons. Repts.*, *Ann. Series*, No. 4,983 [Cd. 6005-156], 1912, p. 11), power for the electrolytic production of hydrogen being obtained from the Hafslund Falls.

Properties of "Hardened Oils"

The hardening of oils by the addition of hydrogen (reduction) in this way can be carried out so that products of varying consistence and appearance are obtained. For instance, if a liquid oil consisting chiefly of olein is completely saturated with hydrogen, the product will consist chiefly of stearin, and will be of hard consistence, while by stopping the process at an earlier stage soft, lard-like fats, consisting partly of stearin and partly of unreduced olein, can be obtained.

The following figures (Bömer, *Zeit. f. Unters. der Nahrungs u. Genüssmittel*, 1912, **24**, 104) show the change in character produced by reducing a typical liquid oil such as ground nut oil:

	Natural ground nut oil.	**Hardened oil.**		
		Slightly.	**Moderately.**	**Much.**
Saponification value .	191·1	188·3	188·4	189·0
Iodine value . *per cent.*	84·4	56·5	54·1	42·1
Melting point, ° C. . .	—	44·2	46·1	53·5
Solidifying point, ° C. .	—	30·2	32·1	38·8
Character of product .	Yellow, liquid.	White, consistence of lard.		White, consistence of tallow.

The reduction, as shown by the gradual lowering of the iodine value, has not been carried to completion, in which case the iodine value would be *nil*; but even by lowering the iodine value by half, the liquid oil has been changed to a solid of comparatively high melting point. The change in colour from yellow to white which takes place at the same time is of great importance, while the fact that the unsaturated and therefore oxidisable glycerides become saturated, and are thereby rendered non-oxidisable, should tend to render the product less likely to undergo change on keeping. Further, the hydrogenation of the unsaturated acids results, it is stated, in the case of fish oils, in the entire removal of the unpleasant odour and, in great part, of the fishy taste. This is one of the most important features of the new process, as, if borne out by practical experience, it will render cheap fish oils available for purposes such as soap-making, for which they are not naturally well suited owing to the difficulty of deodorising them.

"Hardened oils" produced by this process are already on the market under a variety of names, such as "Talgol," "Candelite," etc. They are obviously suited for a number of purposes, such as soap- and candle-making, as they closely resemble in composition and appearance the natural fats already used. Probably the most important feature of the new process is the possibility of the production of solid edible fats from cheap liquid oils; hardened oils of edible quality have been manufactured already, and seem destined to play an important rôle in the margarine and allied industries, but it is at present difficult to give a definite opinion on this point. There seems to be no definite ground for objecting to their sale for edible use, though a certain amount of difficulty is experienced in preventing contamination of the fat with nickel, which is unsatisfactory, but it seems highly probable that eventually means will be found of preventing this contamination. According to Bömer (*Chem. Rev. Fett. u. Harz. Ind.*, 1912, **19**, 221) the presence of free fatty acid in the oil is an important factor in avoiding this contamination, while nickel oxide as a catalyst appears to be less desirable than metallic nickel on account of its greater solubility (Ellis, *loc. cit.* p. 1166). The question of the toxicity of traces of nickel is being investigated by the Bureau of Animal Industry of the United States Department of Agriculture.

Conclusions

The hardening of oils by hydrogenation is already being practised on a large scale, and its extensive use in the oil industry in the future is beyond doubt; it must in fact be regarded as the most important advance in the technology of oils during recent years. The probable effect on the oil and allied industries and on the oil and oil seed markets is exceedingly difficult to forecast, as the full possibilities of the process of hardening oils cannot be gauged until the use of the process becomes more general.

A possible effect that at once suggests itself is the lowering of prices of certain of the harder natural fats, *e.g.* palm kernel and coconut oils, which are largely used in the manufacture of edible substances, while the demand for liquid oils which lend themselves readily to the process of hardening may reasonably be expected to increase, with a corresponding increase in value. The present price of coconut oil is abnormally high, as much as £60 per ton being paid for Cochin oil, largely owing to the great demand for the manufacture of edible materials such as margarine; it cannot be doubted that attempts will be made to replace, either wholly or partially, such an expensive material with artificially hardened oils, if these prove suitable for the purpose. If these attempts prove successful they can hardly fail to have some effect on the demand for coconut oil and similar fats. It is somewhat early in the day to speak definitely as to the cost of hardening oils by hydrogenation, but according to Bömer (*Zeit. f. Unters. Nahrungs u. Genüssmittel*, 1912, **24**, 104) it is about £5 per ton. Liquid oils can be purchased at as low a price as £17 per ton for Japanese fish oil. It should therefore be possible to produce from this material a hardened oil which should be at least equal in value to low-grade palm oil, viz. £26 per ton, at a cost of about £22 per ton. The fact that numerous firms of oil manufacturers are interesting themselves in this process is sufficient to show that it is regarded as likely to prove profitable.

GENERAL NOTES

Report on the Work of the Imperial Institute, 1912.—A summary of the work carried out at the Imperial Institute for the Dominions, Colonies, and Dependencies during 1912 has now been issued in the Annual Series of Colonial Reports, No. 778 [Cd. 7050-19].

Mineral Survey of Southern Nigeria.—Since 1904 there has been in operation in Southern Nigeria a Mineral Survey, conducted under the general supervision of the Director of the Imperial Institute.

Reports on the work of the survey are published periodically in the Miscellaneous Series of Colonial Reports, and those for 1911 (No. 85 [Cd. 7067]) and 1912 (No. 86 [Cd. 7110]) have just been issued. They contain summaries of the field work accomplished in Southern Nigeria, and also the principal results of examination at the Imperial Institute of the minerals of economic importance collected by the Surveyors.

During 1911 the Surveyors were principally engaged in examining the Udi-Okana coalfield, and in investigating its extension, especially northwards. A large number of new outcrops were discovered, and this preliminary work showed that the field is large. Numerous samples of the coal were collected, and the analyses made at the Imperial Institute showed that they were quite similar in character to the coals from other parts of the field examined in previous years. The coal appears, therefore, to be of fairly uniform quality. It is a sub-bituminous coal similar in type to coals which are now largely mined in North America for industrial purposes.

The principal work carried out in 1912 was also in connection with the coal deposits to the north and north-west of Udi, several new occurrences of importance being discovered. Seams varying in thickness from 10 in. to 4 ft. 9 in. were found at various localities in the Okwoga district, proving the northerly extension of the coal deposits well beyond the limit reached during the work of the previous season. Still more important was the discovery of coal of fairly good quality in a seam 1 ft. 8 in. thick in the Iyokolla river, seven miles east of Adani, and fifty-six miles due west of Okwoga station, proving the westerly extension of the coal deposits. This occurrence is of special importance on account of the fact that it is situated only fifteen miles from Ogrugru, on the Anambra river. So far the examination of these coalfields has been limited to surface outcrops, but the fuller investigation by means of boring machinery now in progress may be expected to yield interesting results. The material examined at the Imperial Institute included, in addition to specimens of coal from the various seams referred to above, a clay suitable for the manufacture of fire-bricks; two samples of ironstone, containing 65·65 and 71·78 per cent. of ferric oxide respectively, representing material which would be suitable for the production of steel by the basic process; and two specimens of grey, compact limestone, which would be suitable for agricultural use or for the manufacture of ordinary mortar for building purposes.

South Africa and the Diamond-cutting Industry.—In February 1913 the Parliament of the Union of South Africa appointed a Select Committee to consider the advisability of encouraging the establishment of a diamond-cutting industry within the Union, and the means by which such encouragement may best be effected. The Committee's report was printed and circulated in May 1913, and embodies much evidence of value in connection with the possibility of the establishment of a South African diamond-cutting industry.

The value of the total production of diamonds in the Union up to the present date is estimated at over 170 millions sterling, whilst that for the last twenty years (1893-1912) amounts to over 119 millions sterling. The export of uncut diamonds in 1912 amounted to the local declared value of £10,061,489 from the Union, and approximately £1,800,000 from German South-West Africa. This is a record output, although it does not appear to have exceeded the demand. The value of the diamond production of other countries is small and comparatively insignificant.

The revenue derived by the Union from the diamond-mining industry during 1912 was approximately £800,550. The German Government's revenue during the same year was approximately £363,425.

Notwithstanding the increase in production, there has been a substantial increase in the average price obtained for rough diamonds. It is stated that during the last twenty years diamonds have increased in value by 150 per cent., and in the last five years by 67 per cent.

The output of diamonds is controlled so as not to exceed the demands of the market. The diamonds are elaborately sorted in South Africa, and are then sent to Europe.

It is estimated that there are some 23,000 persons engaged in the diamond-cutting industry, chiefly in Amsterdam and Antwerp, at an annual cost of about £5,000,000. Some cutting is also done in China, England, France, Switzerland, Germany, and America. America is at present the largest buyer of South African diamonds, and some of the best stones are said to be perfected in that country.

Attempts have been made at various times to establish diamond cutting as a business in South Africa. The failure of these attempts is attributed to the inability of South African cutters to secure the requisite amount and variety of raw material, owing to the fact that the large companies send all their rough diamonds to Europe. It is possible to obtain rough stones locally from river diggers, but these do not furnish the variety of material required for the establishment of a successful trade in diamond cutting.

The Committee concludes that it is desirable to establish a diamond-cutting industry in South Africa; that local conditions are favourable for the development of the trade; and that there will be no difficulty in securing foreign skilled labour to carry on the work. To aid in the establishment of this industry, the Committee suggests (1) that the Government, through the medium of its large interest in certain mines, should use its influence to secure such a supply of rough diamonds as may be necessary for local cutters who wish to start in the trade; (2) that a protective tax of 10 per cent. should be imposed as an export duty on the value of all uncut diamonds sent out of the Union.

Mineral Production of the Union of South Africa.—According to the *Annual Report of the Mines Department of the Union of South Africa for* 1912, the total value of the mineral output of the Union for that year amounted to £52,711,761, an increase of £5,032,467 as compared with 1911.

Of this total, gold contributed £38,691,688, which is an increase of £3,642,647 on the value for the previous year. This is 39 per cent. of the world's total production of gold, which for 1912 was estimated to be £98,000,000. The amounts of gold produced by the different provinces were as follows:

	Quantity *Fine oz*	Value £
Transvaal	**9,107,511·562**	**38,686,250**
Cape Province	**38·188**	**162**
Natal	**1,242·061**	**5,276**

The total value of the diamond output for the year was £10,061,489, an increase of £1,314,765 on that for 1911. This output was distributed as follows:

	Quantity. *Carats.*	Value. £
Transvaal	**2,131,406·03**	**2,386,979**
Cape Province	**2,325,548·88**	**6,190,966**
Orange Free State	**614,927·43**	**1,483,544**

Of the total 5,071,882·34 carats produced, 4,887,053·45 were "mine stones," the values of which per carat were 19*s.* 6*d.* for Transvaal, 50*s.* 3*d.* for Cape, and 48*s.* 2*d.* for Orange Free State stones, the average value being 37*s.* 1*d.* per carat. The remaining 184,828·89 carats were obtained from alluvial workings, and their values per carat were 92*s.* 7*d.* for Transvaal, 120*s.* 6*d.* for Cape, and 105*s.* 11*d.* for Orange Free State stones, the average value being 107*s.* 9*d.* per carat.

The output of coal was valued at £1,999,378, an increase of £64,225; that of copper at £556,978, an increase of £4,833; that of tin at £367,699, a decrease of £44,172; and that of silver at £124,374, an increase of £25,867 compared with 1911.

Among the less important minerals there were increases in the output of magnesite, lead ore, mica, corundum, salt, crocidolite and steatite; and decreases in asbestos, graphite, zinc ore, manganese ore, kaolin, limestone, flint, kieselguhr, and verdite.

Mineral Production of British Columbia.—According to the *Annual Report of the Minister of Mines for British Columbia*, the year 1912 was a very successful one from a mining standpoint, and the mineral production was the greatest in the history of the Province. The gross value of the output for the year was $32,440,800, an increase of $8,941,728, or about 38 per cent. on that for 1911.

All the important economic minerals of British Columbia, viz. coal and ores of copper, gold, silver, lead, and zinc, shared in this increased output.

The total output of coal was 3,025,709 tons (of 2,240 lb.), valued at $9,200,814, an increase of 727,991 tons, or 31·5 per cent., on that for 1911; but 113,526 tons less than that for 1910, during which year there was a record output. Of the coal produced 1,882,827 tons was consumed in Canada, 858,981 tons exported to the United States, and 108,157 tons to other countries, whilst 175,744 tons was lost in washing and screening. Of the total Canadian consumption of coal, 396,905 tons was used in the manufacture of 267,564 tons of coke, of which 50,257 tons was exported to the United States.

The most notable feature of the mineral production during 1912 was the remarkable increase in the production of copper, the output of which had an estimated value of $8,408,513. This is a record figure, being 84 per cent. in excess of that for 1911, and a substantial increase on 1908, which was the previous best year. The average assays of the copper ores of the chief fields, based on copper recovered, were as follows: Boundary, 0·87 per cent.; Coast, 3·625 per cent.; Rossland, 0·521 per cent.

The value of the gold output was estimated at $5,877,942, of which $5,322,442 represents lode mining and $555,500 placer mining, corresponding to increases of $596,929 and $129,500 respectively as compared with 1911. Practically all the placer gold was obtained from the Atlin and Cariboo districts. About 75 per cent. of the lode gold production of the Province is obtained from the smelting of copper-bearing ores, the remainder from stamp-milling. The contributions of the three chief camps to the total gold output were: Rossland, $2,729,949; Boundary, $2,167,229; and Nelson, $361,994.

Other significant features of the output were silver, $1,810,045; lead, $1,805,627; and zinc, $316,139; these show increases of $851,752, $736,106, and $187,047 respectively on the outputs for 1911.

Platinum occurs in many of the alluvial gold-workings, but its recovery as a by-product is attended with considerable trouble, and there is consequently no appreciable production of this metal. The discovery of platinum in dyke rocks near Nelson had been reported during the year, but a careful investigation of the supposed occurrence by the Bureau of Mines had negative results.

Iron ore does not figure in the production, although it is stated that there are numerous deposits of considerable size containing ore of good quality.

The Grading of South African Maize, Kaffir Corn, and Jiba.—For several years past regulations for the grading of maize, kaffir corn, and jiba intended for export from South Africa have been issued by the Minister of Agriculture. The approved grades for the 1913 season are given in the following table:

Maize Grades

Grade Mark to be shown on bags	Class	Description
1.	F.W. 1	To be sound, dry, plump, and well cleaned, with a maximum of 3 per cent. of yellow, discoloured, or defective grain.
2.	F.W. 2	To be sound, dry, and reasonably cleaned, and not containing more than 8 per cent. of defective grain and 5 per cent. of other coloured grain.
3.	F.W. 3	To be sound, dry, and reasonably cleaned, and not containing more than 13 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size and shape.
4.	F.Y.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
5.	R.W.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
6.	R.Y.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
7.	F.M.	To be sound, dry, and reasonably cleaned, and not containing more than 10 per cent. of defective grain.
8.	R.M.	To be sound, dry, and reasonably cleaned, and not containing more than 10 per cent. of defective grain.
9.	No grade	To include all maize which cannot be classed in a higher grade, but in dry condition and fit for shipment.

Kaffir Corn Grades

K 1	White	To be sound, reasonably clean, and not to contain more than 5 per cent. of coloured grain.
K 2	Pink	To be sound, reasonably clean, and not to contain more than 10 per cent. of white grain.
K 3	Mixed	To include any other sweet kaffir corn (excluding jiba or jhiba) which cannot be classed under pink or white, provided it is sound and reasonably clean.
K 4	No grade	To include all kaffir corn in dry condition fit for export (including smutty) which cannot be classed in a higher grade.

Jiba Grade

J	Jiba or Jhiba	To include the variety known as jiba, in sound condition and reasonably clean.

In this table F.W. = Flat white, F.Y. = Flat yellow, R.W. = Round white, R.Y. = Round yellow, F.M. = Flat mixed, R.M. = Round mixed.

Samples of the various grades of these products have been placed on exhibition in the Union of South Africa Court, in the Public Galleries of the Imperial Institute.

Cotton Growing in the Ivory Coast.—The cultivation of cotton in the Ivory Coast is receiving careful attention at the hands of the French Colonial Cotton Association, and an account of recent work has been given in *Bulletin de l'Association Cotonnière Coloniale*, No. 57, 1913. A preliminary selection of the numerous varieties of cotton met with in North Bwake has been made by separating the smooth seeds from those bearing fuzz or down with a view to distributing the former to the natives. The smooth-seeded cottons are of two varieties, known as "Guiesse bla" (or female cotton) and "Guiesse yassoua" (or male cotton). The seeds of "Guiesse bla" are free from one another, whereas those of "Guiesse yassoua" are united in groups or kidney-shaped masses of from two to eight seeds.

A study of these two varieties has indicated that "Guiesse bla" is the more suitable for cultivation, for the following reasons: (1) The "yassoua" kind does not behave well on ginning, as the seeds remain attached to one another and impede the action of the saws. (2) The "yassoua" seeds must be detached from one another before being sown, for if a complete group is planted, the roots of the seedlings become entangled and thus render it very difficult to thin out the plants without pulling up the whole cluster; this separation of the seeds by hand adds considerably to the cost of cultivation, since it takes twenty men two days to prepare the necessary quantity (20 kilos.) to plant a hectare. (3) "Guiesse bla" is already more commonly grown by the natives than "Guiesse yassoua," and its fibre is regarded by commercial experts as somewhat more valuable than that of the latter.

Efforts will therefore be made to improve and extend the cultivation of "Guiesse bla" and to establish a uniform type by avoiding the distribution of "Guiesse yassoua" among the natives. Hitherto, there does not seem to have been any difference observed in the plants of these two varieties except in respect of the seed, and it is considered possible that the two forms of the seed may both be derived from one and the same cotton plant, and that the union of the seeds may perhaps be merely an accidental character of certain bolls. Experiments are being made to elucidate this question.

The natives, with the encouragement of the Administration, have planted somewhat largely this season, and the fields have been well tended. Sometimes the plants are cut down at the end of the first season and allowed to grow up again, although it is recognised that cotton of the second year's growth is of comparatively poor quality. Cotton is usually grown in admixture with food-plants, such as maize, cassava and yams, but in the Norhogo region, to the north of Bwake, the natives grow it as a separate crop in well cultivated fields. When, two or three years hence, the railway reaches this district, good cotton harvests may be anticipated.

Cotton Protection Rules in Uganda.—The subject of cotton protection has been dealt with previously in this BULLETIN (1913, **11**, 514) where the regulations made for Nyasaland are described. In Uganda the "Cotton Ordinance Rules, 1909," and "Cotton Ordinance Rules (No. 2), 1909," are being repealed, and "The Uganda Cotton Rules, 1913," of which the following is a summary, have been sanctioned. All cotton must be grown from seed obtained from the Government, and no cotton plants are to be left to produce a second season's crop; all must be uprooted and destroyed within one year from the date of sowing, and the Director of Agriculture may fix a date before which all the previous season's plants must be uprooted and destroyed. Every hand cotton gin in use must be registered annually during October at the Department of Agriculture; and all seed obtained from such gins must be at once destroyed, unless it is being supplied to the Government, or exported, or its germinating power is destroyed. Raw cotton may only be bought by persons licensed by the Director of Agriculture, or by agents having permits from such licensed persons; such permits must be approved by the District Commissioner. No fee is payable in respect of any licence issued under these rules, but the holder of a licence must pay a fee of one rupee in respect of every permit issued by him. The Governor may fix places in any part of the Protectorate for the purchase and sale of raw cotton, and none must be bought or sold elsewhere in such parts. Certain areas may be fixed by the Governor in which the purchase and sale of raw cotton shall be unlawful except under prescribed conditions. All raw cotton and every ginning factory may be inspected at any reasonable time by an officer of the Department of Agriculture.

Certificates of Freedom from Plant Pests.—In view of the legislation enacted by various countries to prevent the introduction of insect and fungoid pests that attack plants (cf. this BULLETIN, 1913, **11**, 334), the Board of Agriculture of the United Kingdom is prepared to issue to nurserymen the certificates required by various importing countries, and they have published in the *Journal of the Board of Agriculture* (1913, **20**, 640) the conditions under which such certificates will be issued. Application should be made to the Board a few days before the consignment is to be despatched. If the plants are to be sent by parcel post they should be sent to the Secretary of the Board in London ready packed in a box, but with the lid not nailed down, and accompanied by the necessary stamps, labels, and Customs declaration. They will then be examined, and if declared healthy or free from certain specified pests, the box will be despatched by the Board. No charge is made for examining a consignment in one box if the gross weight is less than 11 lb. For larger consignments, whether packed in two or more boxes, the charge for packages not exceeding 56 lb. in weight is 2*s*. 6*d*., and for packages between 56 lb. and 1 cwt. 5*s*. Packages above 1 cwt. in weight cannot be examined at the Board's offices, and in such cases special arrangements must be made.

Under the Plant Quarantine Act of 1912 of the United States, nursery stock shipped between October 1 and May 31 must be inspected on or after October 1, and if shipped during the growing season must be examined at the time of packing. Growers who intend to export to the United States should inform the Board as early in the year as possible. Preliminary inspections of the nurseries will be made from time to time during the summer months, and a final examination as early as possible in October. The fee charged will in most cases be £2 2*s*. a year for each nursery, for which sum an unlimited number of certificates and copies can be obtained as required up to May 31 in the following year, provided that the nursery is found to be free from injurious plant disease and insect pests. Any stock shipped between May 31 and October 1 will be examined under the conditions described in the first paragraph.

Nursery stock is not admitted into the United States unless a permit for the entry has been obtained from the Department of Agriculture at Washington by the importer, and the invoice is accompanied by a declaration by the shipper giving particulars as to the place where the stock was grown, date of inspection, permit number, etc. This declaration must be signed by an American Consul. The packages also must be marked with full particulars.

Certificates relating to phylloxera, and to the absence of certain diseases in the neighbourhood in which plants to be exported were grown, can also be obtained from the Board.

The Agricultural Department of the Belgian Congo.—A short account of the work of this department is given in the *Bull. Soc. Belge d'Études Coloniales* (1913, **20**, 500), taken from a letter of M. Aug. Chevalier, which calls attention to the great efforts that are being made to promote the agriculture of the country. Out of an annual budget of £1,800,000, for three years nearly £160,000 per annum has been given to agriculture. The department employs 160 European officials and 10,000 native labourers, and in addition thirty officials are attached to the directorate in Brussels. The department keeps itself well informed of what is being done elsewhere in similar climates, and five or six specialists have been sent to India, Malaya, and the United States, with a view to utilising their observations in the Congo. At the Botanic Garden of Eala, near Coquilhatville, there is a staff of eight Europeans, including a chemist and an entomologist, and 550 natives are employed; the budget of the garden is about £6,000. The area is 250 hectares (618 acres), of which 75 hectares (185 acres) form the botanic garden proper. Here are grown specimens of the useful cultivated plants of all hot countries, and efforts are being made to include all known varieties of the plants producing rubber, coffee, cocoa, cinchona, tea, and bananas, so as to have materials for making experiments to discover those best suited to the country. In the remaining 175 hectares (432 acres) such experiments are carried out; trials are made to see how different varieties of a plant behave under different methods of cultivation, in different kinds of ground, and with and without manure. Great attention is given to all the varieties of coffee trees, the experimental plots being sometimes as much as a hectare (2·47 acres) for each variety. Many practical results have been attained: thus it has been found that in the equatorial zone Hevea grows nearly as well as in Malaya, and gives as much rubber. Already 1,000 hectares (2,470 acres) of it have been planted, and it is proposed to plant in the future 1,000 hectares per annum. Several companies are following this lead, and are beginning to plant Hevea, and plantations of rubber-vines and of Funtumias are being given up. The varieties of coffee tree which are most resistant to diseases and most productive have been determined so that planters can now proceed with certainty. It has been found that tea grows very well in the Congo, but the product is deficient in aroma, and efforts are being made to overcome this defect.

The Agriculture of Abyssinia.—An account of the climate and agriculture of Abyssinia is given by Alfred Kostlan in the *Tropenpflanzer* (*Beihefte* 1913, **14**, 183). The country is remarkable for the great variations in altitude of its different parts, and consequently, although lying within the tropics, it possesses many different climates and exhibits all phenomena of the East African flora, from that of the desert to that of high elevations. It includes most of the desert of Afar near the Red Sea, and two elevated plateaus, namely, that of Abyssinia and that of Somaliland, which stand like islands separated by the great East African trough or depression. The mountains reach 15,000 ft. in height, and in some places it is possible to pass in a few hours from a region of palms to icy plateaus where nothing will grow. The Abyssinians recognise these variations in height and climate and designate localities as "Kolla," or low lands and deep valleys; "Woina-Deka," or land of medium altitude; and "Deka," the upper highlands. Many different classifications of the various climatic zones have been made, but the author thinks that from an agricultural point of view the following is sufficient and appropriate: (I.) Kolla, land up to 1,700 metres (5,600 ft.), divided into Lower Kolla, up to about 1,000 metres (3,280 ft.), and Upper Kolla, ranging from about 1,000 to about 1,700 metres; (II.) Woina-Deka up to about 2,500 or 2,600 metres (8,200 or 8,530 ft.), divided into Lower Woina-Deka, up to about 2,000 metres (6,560 ft.), and Upper Woina-Deka, up to about 2,500 or 2,600 metres; (III.) Deka, land of about 2,600 metres and over, divided into Lower Deka up to about 3,700 metres (12,140 ft.), and Upper Deka, land of about 3,700 metres and over. The Lower Kolla is essentially the zone of tropical, and the Upper Kolla that of sub-tropical vegetation, whilst cereals flourish in the Woina-Deka and the Lower Deka.

Like other places in the tropics, Abyssinia has a rainy season occurring with regularity, though the time of its occurrence is different in different localities. In the coast district of the Red Sea and in the eastern declivity of the high land the rainy season comes in winter, whilst in the whole high land it comes in summer; a narrow strip lying between these has a share of both the winter and of the summer rainy seasons. Adis-Ababa, the capital, situated at an altitude of 8,000 ft., has the highest rainfall of the stations where the fall is recorded. Here the annual fall amounts to 50 in.; October to February are dry, and about one half of the total comes in July and August; the mean annual temperature is 60° F.

The following crops and plants are grown in the zones:

In the Lower Kolla: maize, dura (*Sorghum vulgare*), sesamum (*Sesamum indicum*), Niger seed (*Guizotia abyssinica*), sugar cane, bananas, papaws, coffee, tschat (Abyssinian name for *Catha edulis*), cotton, Sansevieria.

In the Upper Kolla: the same, omitting Sansevieria and adding wheat; barley; ragi (*Eleusine coracana*); teff (Abyssinian name for *Eragrostis abyssinica*), used for making a kind of bread; lablab beans (*Dolichos Lablab*); chillies (*Capsicum abyssinicum*); ginger; *Amomum corarima*; gescho (Abyssinian name for *Rhamnus prinoides*), a shrub the leaves of which, like hops in Europe, are used in making beer; castor oil plant; tobacco; many fruits and vegetables.

In the Lower Woina-Deka: the same as in the last zone, but omitting tschat, ginger, and *Amomum corarima*, and adding oats, rye, peas, beans, lentils, gram or chick pea (*Cicer arietinum*), mustard, coriander, *Nigella sativa*, safflower (*Carthamus tinctorius*), flax.

In the Upper Woina-Deka: wheat, barley, oats, rye, maize, dura, teff, ragi, peas, beans, lentils, gram, Niger seed, mustard, chillies, coriander, *Nigella sativa*, safflower, gescho, castor oil plant, tobacco, flax, and fruits and vegetables.

In the Lower Deka: wheat, barley, oats, rye, teff, peas, beans, lentils, gram, flax, and many fruits and vegetables.

Musa Ensete is grown in the Woina-Deka as a fibre plant, and a kind of bread is prepared from the inside portion of the stem. The fibre is used to make cords, clothes, and artistic bags. Two kinds of coffee are grown, namely Harrar coffee and the so-called Abyssinian coffee. The first was introduced into Harrar from Arabia: the bean is large and of a fine green colour, but somewhat bitter; the quantity produced is not large. The Abyssinian coffee has a smaller bean, also of a fine green colour, with a stronger aroma; it is mostly obtained from wild coffee trees growing in the southern provinces, some is also produced in numerous plantations.

The Abyssinian methods of cultivation are generally primitive and superficial, but in the case of certain plants, for instance, coffee, gescho, *M. Ensete*, and chillies, they are more careful.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.

AGRICULTURE

Soils.—In the analysis of soils by the usual process of acid digestion of the material passing a 1 mm. sieve, the quantity of phosphoric acid found is sometimes considerably less than that found by the fusion method.

An account of an investigation of this point carried out by the Soils Bureau, U.S. Dept. Agric., is given in *Journ. Indust. and Eng. Chem.* (1913, **5**, 566). It was found that acid extraction removed from 4 to 100 per cent. of the total phosphoric acid present in a number of soils examined, and mineralogical analyses of the soils giving low results showed that they contained apatite enclosed in quartz grains, and therefore protected from attack by acid. It is suggested that a minor factor contributing to this deficiency is the presence in minute quantity of phosphates insoluble in hydrochloric acid.

The partial sterilisation of soils by means of lime is discussed in a paper by H. B. Hutchinson in *Journ. Agric. Sci.* (1913, **5**, 320). The investigation, which was carried out at the Rothamsted Experimental Station, was undertaken in order to account for certain results obtained when lime is applied to soils, which are not explained by the increase in plant food caused by liming. It has been found that, as an antiseptic, lime has an effect intermediate between that of volatile solvents, such as toluene, and that due to sterilisation by burning (see this BULLETIN, 1911, **9**, 290). Laboratory experiments showed that the effect of the lime when added to the extent of 0·25 to 1·0 per cent. was to destroy many bacteria, to cause a large diminution in bacterial activity, and to kill the larger protozoa. The diminution in bacterial activity continued until all the lime was converted into calcium carbonate, when bacterial activity and the supply of available plant food both increased. The results of pot culture experiments largely confirmed those obtained in the laboratory.

Manures.—Amongst the substances recently suggested and used for manurial purposes is the loggerhead sponge. According to a recent communication from the Soils Bureau, U.S. Dept. Agric., published in the *Journ. Indust. and Eng. Chem.* (1913, **5**, 850), these sponges contain, when air-dried, almost 4 per cent. of nitrogen, and from 0·75 to 1·0 per cent. each of phosphoric acid and potash. The organic matter amounts to about 40 per cent., and the lime and magnesia (chiefly lime) to about 5 per cent. These sponges grow in profusion in the shallow waters of the Florida Keys, and are used locally as a manure. They are said to be suitable for manuring citrus trees.

FOODSTUFFS

Maize.—In most varieties of maize the anthers open previously to or simultaneously with the appearance of the silks (stigmas) on the same plant, and pollen is still falling when the silks are in a receptive condition. For this reason self-pollination, which is said to reduce the vigour of the maize plant, is more likely to occur than cross-pollination. On the other hand, if the stigmas should ripen first, the proportion of cross-pollinated seed would be greatly increased, to the advantage of the plants, while self-pollination could still take place in the event of cross-pollination failing. This question is dealt with in *Circ.* No. 107, 1913, *Bur. Plant Ind. U.S. Dept. Agric.*, which records the discovery of a proterogynous maize in Granada, Spain. This variety is a red maize, having very small ears, and of practically no economic importance. The discovery is recorded, however, in the belief that those interested in developing new types of maize will find valuable breeding material in this strain.

Sugar.—The *Agric. Journ., Union of South Africa* (1913, **5**, 931) records a new sugar cane pest in Natal. The attack was investigated by the Assistant Chief of the Division of Entomology, who reported that the trouble was caused by a moth caterpillar, which webs together the immature leaves forming the spike of the cane. The pest occurred on "Uba" cane, 99 per cent. of the spikes being infested, while adjacent plants of the "Black Seedling" and "Green Cane" varieties were immune. The damage was not serious, as the depreciation brought about by the destruction of a certain amount of leaf tissue, and the delayed activity of the enfolded leaves, are of minor importance. On this account the control of the insect at present does not call for serious consideration.

OILS AND OIL SEEDS

Castor Seed.—The castor oil plant is generally stated to be almost immune from fungoid pests, but the crop has been found to be attacked in India by a species of *Cercospora*, and also by a species of *Phytophthora*. The damage caused by *Cercospora* is confined to the leaves, and is not fatal to the plant. It is, however, a serious menace to the eri-silk industry, as the leaves of the castor plant form the food of the eri-silk caterpillars.

The species of *Phytophthora* has been fully investigated by Dastur (*Mem. Dept. Agric. India, Bot. Ser.*, 1913, **5**, 177). It appears to be the most serious fungoid pest of this crop in India, as it destroys seedlings and also attacks older plants. It is most prevalent in abnormally damp seasons, and in low-lying or badly drained localities, where 30 or 40 per cent. of the seedlings may be killed. The first indication of the disease is the appearance of a roundish patch of unhealthy, dull green colour on both surfaces of the cotyledons, which next hang down from the point of attachment. The disease then spreads to the petiole, and thence to the growing point of the plant. In older plants the disease is localised on the leaves, where it causes brown patches, the leaves having a tendency to fall prematurely. In the field the disease does not appear to attack the tougher parts of the castor plants, such as the petioles of large leaves and stems with thick epidermis, or the fruit and flowers, although these portions are readily attacked when inoculated in laboratory experiments; this difference is said to be due to the different climatic conditions to which the field crop is exposed. The author has investigated fully the morphology of this pest, and concludes that it is a new species, for which the name *Phytophthora parasitica* is proposed.

Coconuts.—Attention is drawn in the *Times* of July 1, 1913, to the possibility of establishing further coconut plantations in Zanzibar. The tree does well in the island, and good copra is produced, although no mechanical drying plant is yet used. The copra exported during 1912 was valued at £190,937.

The larvæ and adult insects of the coconut leaf-miner beetle (*Promocotheca cumingii*, Baly) have been found to attack young coconut trees in the Philippine Islands (*Philippine Agric. Rev.* 1913, **6**, 228). So far old palms have not been attacked. It is recommended that infested leaflets should be removed and adult beetles, etc., destroyed.

An article entitled "Copra and Margarine," in the *Times* of October 20, 1913, calls attention to the increasing importance of copra caused by the large demand for coconut oil in the manufacture of edible fats and in other industries. The information given is quite useful, but a number of statements are made which require to be supplemented; for instance, it is stated that "the present-day high value of copra is due to the oil it contains; the commercial importance of copra begins and ends with the presence of this oil." The oil is certainly the most valuable product, but no mention whatever is made of the residual oil cake, of which enormous quantities are produced, and which sells for about £8 per ton.

The native method of preparing coconut oil by crushing and boiling the "meat" is alluded to as having been employed "in early times"; it would be more correct to say "since early times," as the process is still largely used, and some of the highest-grade oil on the market, viz. "Cochin" oil, is produced by this means.

It is also stated that "the majority ship their produce in the form of copra" and "the oil may be said to concern, comparatively, a very limited number of refiners and manufacturers"; this is misleading in view of the very considerable quantities of oil exported from India and Ceylon, and produced there by machinery or by native methods.

It is also stated that coconut oil is now used as salad oil; it is of course possible that coconut olein (see p. 661) could be used for this purpose, but it is most unlikely that any appreciable quantity has been put on the market as salad oil.

The statement that the "cream" of chocolates is "often made of coconut oil" does not correspond with recently published information on this point. Thus Bolton and Revis (*Fatty Foods*, p. 72) state that the "cream" of chocolates does not contain fatty matter, but is composed of sugars and starch. What is probably meant is that the natural cocoa-butter of cocoa nibs is often expressed and sold as such, the residual cocoa being then mixed with a cocoa-butter substitute made from coconut oil for conversion into the chocolate paste used for covering chocolate creams. Quantities of coconut oil are used in making the "icing" layer of ice-wafer biscuits and in the manufacture of sweets and other confectionery, but no mention is made in the *Times* article of these uses. From the prominence given to the "new tasteless and long-keeping form" of coconut oil it might be imagined that the preparation of edible coconut oil was a very recent innovation, whereas large quantities have been produced for years past; in fact, Lewkowitsch mentioned the increase in the manufacture of edible coconut oil in 1909 (*Chemistry, Technology, and Analysis of Oils, Fats, and Waxes*, ii. 518), and stated that the quantity produced "a few years ago in Europe alone" was "about 10,000 tons per annum and rose rapidly to 50,000 tons."

The reference to "doubtful animal fats" used in margarine manufacture is somewhat belated, since, although the use of coconut oil in margarine has undoubtedly increased enormously during recent years, very large quantities of animal fats and oils are still used, and the conditions of manufacture are now beyond suspicion, whatever may have been the case in the past.

The statement that Continental firms are making from milk and coconut oil a "butter as wholesome, real, and palatable as the best dairy butter" is far too daring; such a material may be as wholesome and palatable as butter, but one need only consult any reliable work on food analysis to see that no court in the United Kingdom would allow the sale of such a substance as "real butter."

Ground Nuts.—The cultivation of ground nuts in Gujerat was formerly considered unprofitable, but experiments made recently show that this view is hardly correct. The crop is now recommended by the Agricultural Department (*Agric. Journ. India*, 1913, **8**, 178), and its cultivation in this district is increasing gradually.

The chief drawbacks to its cultivation appear to be (1) liability to damage by crows, theft, etc. This difficulty should be gradually overcome as the crop becomes more general; moreover, such a valuable crop should pay for careful watching. (2) The high cost of cultivation. It was found that the cost of cultivation of the late varieties tested was about Rs. 113 per acre, the profit being about Rs. 12 with Senegal nuts and about Rs. 62 per acre with Tamboo nuts. The early varieties only cost about Rs. 80 per acre, the profits being Rs. 71 with small Japanese nuts and about Rs. 52 per acre with Spanish nuts. (3) Scarcity of labour for harvesting. This can be obviated to a great extent by growing early varieties, which mature when there is less demand for labour, and which are easier and cheaper to harvest. The early varieties cost about Rs. 31 per acre to harvest; the late varieties have to be hand-dug owing to the hardness of the soil, and cost about Rs. 63 per acre, but this difficulty can be overcome by judicious irrigation where this is possible. It is concluded that ground nuts can be made as profitable in Gujerat as tobacco, which is the principal money-making crop. The ground nut possesses the advantage of being fairly resistant both to drought and wet, and is also comparatively free from attacks of white ants or hairy caterpillars (*Katras*) which cause much damage to other crops. Ground nuts are also valuable in the rotation of crops; a three years' rotation of cotton, ground nuts, and bajri (*Pennisetum typhoideum*) being recommended.

Experiments in Sierra Leone with Gambia ground nuts (*Ann. Rept. Agric. Dept. Sierra Leone*, 1912, p. 9) have shown that better crops are obtained if the nut shells are removed before sowing; the Konnoh tribesmen split one end of the shell with a view to assisting germination. The yields obtained in the experiments were not very good, probably owing to late sowing and to the attacks of rats, hogs, and termites. Further experiments are to be made with a view to ascertaining whether deep hoeing leads to an increased crop, as is the case in other countries.

Oil Palm.—The comparatively small quantity of palm kernels exported from the Eastern Province of Southern Nigeria is further discussed by Unwin (*Nigerian Customs and Trade Journ.* 1913, **3**, 319; cf. this BULLETIN, 1913, **11**, 525). It is suggested that the introduction of nut-cracking machinery will tend to a greater production of kernels, as many kernels are wasted at the present time. The machines are somewhat expensive for purchase by natives, but could be supplied to chiefs and other responsible people on a hire-purchase system. Nut-cracking machines have been installed at some places, *e.g.* Degema, and a large increase in production at these places has resulted; in fact the natives are bringing in more nuts than can be dealt with, while hand cracking is being abandoned in some districts. It is suggested that skilled men might be placed in the markets to crack nuts by machinery, and also that natives should be encouraged to cultivate the palms in plantations and not to rely on the scattered wild trees. The primitive devices used for cracking nuts by hand might also be improved on by the use of an iron block and a handleless striker or "maul" (*Nigerian Customs and Trade Journ.* 1913, **3**, 291, 324).

Para Rubber Seed.—In a note published in the *Tropical Agriculturist* (1913, **40**, 311) Wicherley calls attention to the fact that Para rubber seed has been sold in Ceylon at prices which yield a profit of about £1 per ton to the planters. A large firm of oil manufacturers in England valued the kernels at about £9 10*s.* per ton, and stated that there would be no difficulty in disposing of 1,000 tons. Some difficulty seems to be experienced in separating the kernels from the shells, while the kernels are said to be liable to attack by insects unless thoroughly dried.

Several thousands of tons are reported to have been offered for sale in the Malay States, but the prices asked were prohibitive for export purposes.

Soy Beans.—It has not been found possible to cultivate soy beans with success in Montserrat (*Rept. Botanic Station, Montserrat*, 1911–12, p. 2). Five generations have been grown on the same plot, but the plants have never exceeded 8 in. in height, and have generally borne only about a dozen pods each. Soil from Trinidad in which soy beans had been grown successfully was sown with the beans in one case, in the hope of inoculating the soil with the nitrogen-fixing bacteria; but this had no beneficial result.

Miscellaneous.—The oil from the seeds of the Ceara rubber tree has been examined by Rideal and Acland (*Analyst*, 1913, **38**, 259), with similar results to those already recorded in this BULLETIN (1906, **4**, 364). The authors appear to consider that the seeds are likely to be of commercial value as a source of oil. The seeds, however, only contain 15 to 16 per cent. of oil, and consist of about equal proportions of kernel and hard woody shell which cannot be removed easily from the kernel. The only feasible method of obtaining the oil from such seeds would be to grind the whole seeds and to extract the oil by solvents. Such processes are of course largely used in Europe, but are not yet employed in the tropics, while it would obviously be unremunerative to attempt to ship seeds with so low an oil content and so large an amount of hard woody shell to European oil mills.

The same authors (*loc. cit.* p. 259) also examined the seeds of *Funtumia elastica*; these were found to contain 31 to 33 per cent. of oil which resembles that from Ceara and Para rubber seed. The seeds are stated to contain cyanogenetic glucosides.

The seeds of the soft-shelled pinon or grey pine (*Pinus monophylla*, Torr. & Frem.), which grows on the slopes of the Sierra Nevada Mountains, are gathered for food in large quantities by the Indians. Adams and Holmes have examined these seeds (*Journ. Indust. Eng. Chem.* 1913, **5**, 285), and state that the air-dry kernels contain from 16 to 22 per cent. of oil, which was found to consist chiefly of olein, with smaller amounts of glycerides of stearic, palmitic, lauric, and linoleic acids. No information is given as to the possibility of using the seed as a commercial source of oil.

RUBBER

Hevea brasiliensis.—In *Bulletin Dept. Agric. Ceylon* (1913, No. 4, p. 61), the Director of Agriculture gives the results of tapping old trees at Heneratgoda systematically for 3½ months. One tree already noted for its high yield (see this BULLETIN, 1911, **9**, 427; 1912, **10**, 495) gave a total yield of

45 lb. 3½ oz. of dry rubber. The next most productive tree yielded 24 lb. 9¼ oz. of dry rubber. The general result of the experiments is that the most productive trees are those which have the most room to extend. The author points out that *Hevea brasiliensis* must have room to extend in at least one direction (in one case the root was found at a distance of 80 ft. from the trunk), and recommends planting the trees in fours, each four at some distance from the neighbouring fours, so that every tree may extend fully on two sides.

Tapping experiments are also described by Dr. A. W. K. de Jong in the *Mededeelingen No. IV. van het Agricultuur Chemisch Laboratorium, Departement van Landbouw, Nijverheid en Handel, Buitenzorg*, 1913. The experiments were designed to test the effect of direction and angle of slope of the tapping cuts. Numerous tables are given showing the results of individual tappings. It was found that cuts of equal length, at the same height from the ground, and sloping in the same direction, yield practically the same weight of rubber, whether the cuts are 5 cm. apart or on opposite sides of the tree. A long cut yields less rubber than two shorter cuts which are together as long as the long cut, and slope in the same direction. In the case of cuts of equal length, at the same height from the ground, and sloping at the same angle but in different directions, it was found that those sloping up to the left gave an average of 15 per cent. more rubber than those sloping up to the right when they were on the same side of the tree. Also, when the cuts were on opposite sides of the tree those sloping up to the left yielded 10 per cent. more rubber than those sloping to the right. The author explains these results as due to the fact that the laticiferous vessels of *Hevea brasiliensis* incline somewhat to the right as stated by Petch (*Physiology and Diseases of Hevea brasiliensis*, pp. 111, 112). The cuts sloping up to the left will therefore cut more vessels than those sloping up to the right, and tap more latex.

Numerous tables are given showing the relation of the yield of rubber to the angle of inclination of the cuts; the cut which runs perpendicular to the direction of the laticiferous vessels will tap the maximum number and yield the greatest amount of latex. The author concludes that the herring-bone system, the V system, and the cuts sloping up to the right, are less rational than the cuts inclined to the left.

The same journal (p. 35) describes an experiment on the effect of manures on the growth of *Hevea brasiliensis*. Two hundred and fifty-two trees were experimented with in eight series. Superphosphate of lime, chloride of potash, and sulphate of ammonia, either alone or mixed, were applied on April 12, 1911, and again at intervals of from two to four months up to August 2, 1912. The girth of the trees was measured on November 20, 1911, April 8, 1912, and November 17, 1912. The average increase of girth per tree of the manured over the unmanured trees for 1½ years was 1·25 cm. in the case of the mixture of all three manures, 1·2 cm. for a mixture of chloride of potash and sulphate of ammonia, and 1·1 cm. for sulphate of ammonia alone.

Thus, as far as increase of girth is concerned, sulphate of ammonia has almost as much effect as the full manure. Superphosphate alone has little effect on the increase of girth, which is not surprising, since phosphorus is used by the plant chiefly for the production of seed.

The experiment, however, is not regarded as conclusive, as the soil content of plant food was not known; moreover, the trees may have benefited from the manures applied to neighbouring trees.

The *Journ. Bd. Agric. Brit. Guiana* (1913, **7**, 37) contains a note on a fungus which appears to be a new species and has been named *Passalora heveæ*, Massee. This fungus was found on the leaves of young Hevea trees, where it forms spots which increase in size, producing dried areas which eventually fall away from the green parts, leaving holes in the leaf surface. As preventive and remedial measures the author recommends destroying all affected leaves and spraying with a lime-sulphur wash.

The *Ann. Rep. of the Agric. Dept., Southern Nigeria*, 1912, states that Southern Nigeria is eminently suitable for the growth of *Hevea brasiliensis*. The department has two small Para plantations, of about 3,000 trees each, of a tappable age, one at Agege and the other at Calabar, and it is proposed to carry out extensive tapping experiments. At Agege a number of trees have succumbed to attacks of *Hymenochæte noxia* and *Fomes semitostus*. At Ebute Metta four trees, two *Hevea brasiliensis* and two other *Hevea* species, were tapped on alternate days from June 22 to December 31 by a modification of the half herring-bone system. The two *H. brasiliensis* trees gave 14 lb. 9¼ oz. of dry rubber, the other two yielded 13 lb. 4 oz. Thus the average yield was 6 lb. 15⅜ oz. of dry rubber per tree.

General.—The *Gummi Zeitung* (1913, **27**, 1611) describes a mechanical device for tapping rubber trees invented by G. M. v. Hassel. It consists of an apparatus attached to the tree by means of two chains, and possessing tapping knives actuated by springs which are released by means of an electric current. The current is supplied by means of a small dry battery in a central place, from which any number of trees fitted with the apparatus may be tapped simultaneously by a single person.

FIBRES

Silk.—An account of the efforts to improve the silk industry of Bengal is given in the *Rep. Dept. Agric., Bengal, for the year ending June* 30, 1912. In order to obtain a supply of disease-free seed for distribution, nineteen nurseries or rearing houses have now been established, each of which has a mulberry plantation attached to it. The three chief breeds of Bengal silkworms, Chotapalu, Nistari, and Barapalu, are all multivoltine breeds, whilst those of China, Japan, and Italy are univoltine. In order to improve the character of the Indian silk it was suggested by Mr. Lefroy, the Imperial Entomologist, that attempts should be made to hybridise European univoltine worms with the best Indian multivoltine races. For the purpose of carrying out this work, the services have been secured of a European expert who has been specially trained in Mendelian principles. Some hybridised seed has already been produced and distributed to rearers, and the results of the experiments are being awaited with considerable interest. Italian mulberry is being cultivated with success and has been found to prevent "grasserie." Special instruction is provided at the Miraanj Sericicultural Station and at the Sericicultural School at Rajshahi.

A report on the silk farm at Peradeniya, Ceylon, has been published in the *Tropical Agriculturist* (1913, **40**, 350). The farm has been under the management of the Salvation Army for about 2½ years. It consists of about 7 acres, the whole of which has been planted with various kinds of mulberry. The following kinds of silkworms have been cultivated: (1) French univoltine; (2) Indian varieties of the mulberry silkworm, viz. Barapalu, Nistari, and Mysore; and (3) eri silkworms, which feed on the leaves of the castor oil plant. It is also proposed to carry out experiments with the Muga silkworm; the silk of this variety is unknown in European markets, but is readily saleable in India. Arrangements are in progress for the establishment of a silk-mill in Colombo, where the silk will not only be reeled, but twisted, woven, and dyed. It will thus be possible to give instruction in the Island in all the processes of silk manufacture.

New Zealand Hemp.—It was pointed out in this BULLETIN (1907, **5**, 45) that an endeavour was being made to re-establish the fibre industry in St. Helena, with the assistance of the Government. In 1908 a fibre-mill was established and an account of the operations of this mill and the progress of the industry are recorded in *Colonial Reports, Annual No.* 756, *St. Helena, Report for* 1912 [Cd. 6667-4]. In 1912, 1,202 tons of *Phormium tenax* leaves were treated, with the production of 114½ tons of fibre and

35 tons of tow. The fibre realised an average price of £25 17s. per ton and the tow £16 3s. per ton, and the year's working resulted in a profit of £282, or £462 if the value of that portion of the crop on hand at the end of the year is included. It is considered that the industry has now advanced beyond the experimental stage and that it is in a condition to be undertaken by private enterprise and capital. It is probable that a local firm will shortly erect a mill, but this, on account of its situation, will not affect the western part of the island, where the need and possibility of development are greatest.

Carludovica palmata.—In a recent note in the *Philippine Agric. Rev.* (1913, **6**, 253), M. M. Saleeby refers to an experiment made in the Philippines with *C. palmata*, a plant which grows in shady places in Panama and in the coast regions of Ecuador and Colombia. This plant bears fan-shaped leaves about 4½ ft. in diameter, which are employed for the manufacture of panama hats. The method of preparing the leaves is described as follows: The leaves are cut before they are expanded, and the woody ribs, or stiff parallel veins, are removed. The leaf is then slit into narrow strips, which remain attached at the stalk end. These strips are immersed in boiling water for a short time, and are afterwards dried and bleached in the sun. When completely dry, the strips roll up into a straw-like form, and are then bleached in preparation for hat-weaving. *C. palmata* is now cultivated in Java, and hats are being woven by the women and children, and it is stated that the Java panama hat compares favourably with the common grades made in Panama. The conditions in the Philippines appear favourable to the growth of the plant, and the natives excel in the art of hat-making. It is, therefore, considered that the panama hat industry could be established with success in those provinces in which hat-weaving is the chief household industry.

Paper-making Materials.—In *Bulletin* No. 38, 1913, *Forestry Branch, Dept. of the Interior, Canada*, entitled "Forest Products of Canada, 1912: Pulpwood," an account is given of the pulpwood industry in the Dominion during 1912. The amount of pulpwood cut was 1,846,910 cords, of which 866,042 cords were converted into pulp in Canada, whilst the remainder was exported to the United States. There were 48 mills in active operation during the year, and the quantities of wood consumed in the different Provinces were as follows: Quebec, 578,855 cords; Ontario, 173,903 cords; New Brunswick, 52,041 cords; British Columbia, 35,067 cords; Nova Scotia, 26,176 cords. Of the total quantity, 677,747 cords consisted of spruce; 164,587 cords of balsam fir; 19,178 cords of hemlock; 4,405 cords of poplar; 85 cords of larch; and 40 cords of pine. As much as 57·6 per cent. of the wood was converted into groundwood pulp by the mechanical process; 33 per cent. was treated by the sulphite process; 7·7 per cent. by the sulphate process; and 1·6 per cent. by the soda process.

Cotton

Sudan.—In an article in this BULLETIN (1913, **11**, 192) it was mentioned that a large quantity of cotton is exported from the Sudan in the unginned state. This cotton has hitherto been consigned to Egypt for ginning. It is stated, however, in the *Reports on the Finance, Administration, and Condition of the Sudan*, 1912, vol. ii., that during the present year (1913) the Egyptian Government are prohibiting the importation of unginned cotton from the Sudan in order to prevent admixture of seed. In future, therefore, all cotton grown in the Sudan will be ginned before export. The excellent results obtained at the Tayiba Experimental Station in the Gezira (this BULLETIN, 1913, **11**, 190) have led to numerous applications for plots of land from the surrounding villages. The above-mentioned report gives a detailed account of the Tayiba experiments and also of those carried out at Tokar. An Ordinance ("The Cotton Ordinance, 1912") has been enacted with the object of improving and maintaining the quality of Sudan cotton, and provides for the issue of regulations with regard to the seed to be sown, the picking of the cotton in a clean state, free from leaves, capsules, and dirt, the destruction of the cotton plants at the end of the season, the ginning of cotton, the licensing of ginneries, and other matters connected with the control of the industry.

Southern Nigeria.—The cotton industry of Southern Nigeria continues to make satisfactory progress. In the *Ann. Rep. Agric. Dept. for the year* 1912, it is stated that 39,043 cwts. of cotton were exported during the year, and that the crop in the Western Province in 1913 will probably exceed all previous records. The Ishan native cotton, which is regarded by the British Cotton Growing Association as the most satisfactory type produced in any part of West Africa, has again given good returns, and 2,796 lb. of selected seed were distributed to farmers in the Ibadan district. The native varieties of cotton growing at the Moor Plantation were affected with a disease which has not yet been identified. Hybridisation experiments have therefore been made with the Ishan and five American varieties with a view to establishing a form combining the good qualities of both these types with a greater resistance to disease than is possessed by the cottons now grown in Southern Nigeria.

Ceylon.—An experiment has been made at Ambalantota on the cultivation of the American Upland cotton known as "Allen's Long Staple." According to the *Tropical Agriculturist* (1913, **40**, 315), a yield of 1,043 lb. of seed-cotton was produced per acre, which is the largest yield yet obtained in Ceylon. The cotton was very clean, of silky appearance, fine, and 1¼ to 1½ in. long. In view of this encouraging result, it is probable that during the next season about 200 acres will be planted in the Hambantota District.

Jamaica.—Although the efforts made during the last ten years to establish cotton growing on a large scale in Jamaica have not met with success, a useful industry is now being developed among the small holders in the Vere district. In the *Ann. Rep. Dept. Agric., Jamaica, for the year ended March* 31, 1913, it is stated that Sea Island cotton was exported during the year to the value of £2,727. Almost the whole of this was produced at Vere, where 500 acres are now under cultivation. The new industry has fortunately been free from the persistent attacks of the cotton worm, which caused so much damage during 1904–7.

FORESTRY AND FOREST PRODUCTS

Afforestation of Sand Hills.—The afforestation of the sand hills of Nebraska and Kansas is discussed in *Bulletin* No. 121, 1913, *Forest Service, U.S. Dept. Agric.* The sand hill regions comprise a total area of 15,000 square miles, nearly one-tenth of the combined area of the two States; they are unfitted for agriculture in their present condition, and are therefore very suitable for afforestation purposes. Nebraska and Kansas have only a small proportion of natural forest land, and produce practically no soft timber. Thus the planting of these regions will not only improve the character of the soil and provide wind-breaks for the fertile agricultural lands to the east, but also assure a future supply of lumber for these States when that of the North-West becomes depleted. The problem of afforestation here is simpler than that of coastal dunes, since in these hills there is very little shifting sand, and the native vegetation, consisting chiefly of grasses, quickly takes possession of new dune formations. After careful experiments it has been found that in Nebraska the Jack, Western yellow, Scots, and Norway pines have succeeded best; whilst in Kansas, where planting has been in progress a much shorter time, and hence the adaptability of species is not so definitely proved, the drought of 1911 has shown the green ash, Western yellow pine, honey locust, and red cedar to be the most resistant trees. The general considerations which make for the greatest success in sand-hill planting appear to be the use of well-grown, seasoned transplants raised in adjacent nurseries, together with planting in the early spring, immediately after the frost, when the soil is moist.

The Forest Flora of the Gold Coast.—*A List of Trees, Shrubs, and Climbers of the Gold Coast, Ashanti, and the Northern Territories* (London: Waterlow & Sons, 1913), prepared by Mr. T. F. Chipp, has just been issued. The list is preliminary, and includes only those species actually encountered by the author in the course of his work as Assistant Conservator of Forests. The plants are arranged in systematic order, the botanical and native names of each species being given, together with particulars of the herbarium specimens examined, and short economic notes. The list is well furnished with indexes. The work, though primarily intended for the use of forest officers, will also be of use to all interested in the natural resources of the country.

Timbers

Malayan Timbers.—It is estimated that there are at least one hundred useful kinds of timber-yielding trees in the forests of the Malayan Peninsula, and in order to facilitate their identification, by forest officers and others, the Conservator of Forests has in preparation a series of notes which will be published from time to time as data become available. Two instalments have been received recently at the Imperial Institute (*Trees and Timbers of the Malay Peninsula*, Part I., April 1911; Part II., December 1912), and these deal with species belonging to the genera Balanocarpus, Afzelia, Shorea, Durio, Artocarpus, Dyera, Fagræa, Melanorrhœa, Slœtia, Oncosperma, Quercus, Sindora, Cratoxylon, and Casuarina. Many of these species yield valuable timbers that are employed locally, but, with the exception of chengal (*Balanocarpus* spp.), are not exported.

The notes supply information as to the distribution of the trees and their appearance in the forest, and special attention has been given to the barks, on the taste, smell, or appearance of which the Malays mainly rely for purposes of identification. The character, weight, and principal local uses of the woods are also stated, and the photographs of sections of the woods, enlarged three diameters, are intended to assist their identification. In most cases a detailed botanical description of the trees is quoted from an authentic source, and where possible photographs of the trees *in situ* accompany the descriptions.

The Assam Tea-box Industry.—Reference to the tea-box industry of Assam has been made already in this BULLETIN (1911, **9**, 311). An account of the investigations into the industry which formed part of the programme of research work at the Forest Research Institute, Dehra Dun, for the triennial period 1910–13, is given in *Indian Forest Records* (1913, **5**, 1). Upwards of thirty species of timber are utilised for the locally made tea-boxes, by far the most important of these being nam-dela (*Duabanga sonneratoides*), tulla or bhelu (*Tetrameles nudiflora*), simul (*Bombax malabaricum*), and dumboil (*B. insigne*). Fairly large supplies of these timbers are thought to be still available, but practically everywhere in the neighbourhood of the saw-mills they have been exploited, and now have to be brought considerable distances from the forests, which renders the cost of extraction excessive. The Cachar and Sylhet Divisions, where most of the local hand-sawn tea-boxes are made, obtain their supplies from the Unclassed State Forests of Cachar and Sylhet and from the Lushai and Manipur Hill tracts. In the year 1910–11 the outturn of locally made tea-boxes of all sizes in the various divisions was 834,952. The number of tea-boxes imported into India in 1911–12, so far as can be ascertained from the returns available, was 1,869,841, valued at Rs. 44,72,998 (£298,200), an increase of nearly 100 per cent. in five years. This increase is in part due to the expansion of the tea industry, but is also largely a result of the increased tendency on the part of planters to use imported shooks in preference to the locally made tea-boxes. The difficulty with the local tea-box is that the timber of which it is constructed is liable to be attacked by insects, and if incompletely seasoned is liable to corrode the lead used for lining the boxes and to "taint" the tea. Experiments have been started at the Forest Research Institute with a view to devising a cheap and simple method of treating tea-box timber in order to render it immune from insect attacks and at the same time harmless to the contents of the boxes. Details of these experiments are given, but as they are not yet completed it is too early at present to state that they will prove successful. With a view to increasing the supply of simul timber, from which about 80 per cent. of the local tea-boxes are made, it is suggested that certain areas on the north bank of the Brahmaputra, in the Lakhimpur Division, be reserved and protected, as it is thought that the crop of simul seedlings would then be sufficient within a few years to fully stock these areas.

Railway Sleepers of Pyinkado (*Xylia dolabriformis*).—The possibility of exporting pyinkado sleepers from Burma for use on the Indian railways is discussed in a note which appears in the *Indian Forester* (1913, **39**, 256). So far only a small number of pyinkado sleepers have been exported, and this is due, not to an insufficient supply of the timber, but to other causes, the more important of which are: the difficulty of extracting pyinkado, as it will not float;

the want of lines of communication other than streams; the demand for cheap sleepers by the Burma railways; the cost of conveying railway sleepers to Rangoon; and the high price obtainable in Burma (especially in Rangoon) for pyinkado scantlings and rafters.

Recently the Upper Burma Wood Company have commenced to extract pyinkado from the Yeni Reserve in the Pyinmana Division, and, in this connection, a tram line 12 to 14 miles in length has been laid down between the forest and Ela, at which latter place an up-to-date saw-mill has been erected. It depends much on the success of this undertaking whether the pyinkado business expands or not in the next few years.

The local up-country price for middle-gauge pyinkado sleepers of the first quality is Rs. 1-12 each, or roughly Rs. 56-8 per ton, and for second-quality sleepers Rs. 1 each. The prices for pyinkado rafters, scantlings, boards, and planks in Rangoon are from Rs. 75 to Rs. 80 per ton (January 1913), calculated at 50 cubic ft. per ton. Estimating the cost of broad-gauge sleepers at Rangoon on this basis, their value would be Rs. 5 each, or about as much as the railways would pay for them landed in India. The present price of pyinkado is therefore almost too high to make sleeper extraction profitable.

Should the Burma railways be able to supply all their requirements during the next few years at the local price of Rs. 1-12 per sleeper, it is not improbable that they will reconsider their freight charges for pyinkado, which, owing to the weight of this timber, are at present rather high. In this event the local prices for converted pyinkado timber in Rangoon would fall, and should the sleeper-timber price in India remain as at present, or advance, it is thought the export of pyinkado broad-gauge sleepers from Burma might become a profitable undertaking

Greenheart.—A description of this important timber tree is given in *Circular* 211, 1913, *Forest Service, U.S. Dept. Agric.* Greenheart (*Nectandra Rodioei*, Hook.) occurs over an extensive area on the mainland of South America, and in the West Indies; but it is only worked in British Guiana, where it forms the second most important article of export. Greenheart is unsurpassed for certain purposes; its immunity from the attacks of the teredo under water, and of white ants on land, rendering it of special value in connection with ship and dock building, the construction of bridges, etc.

Walnut.—An account of the Circassian or English walnut (*Juglans regia*, Linn.), which yields one of the best-known cabinet woods on the European and American markets, is given in *Circular* 212, 1913, *Forest Service, U.S. Dept. Agric.* From very early times it has had a most extensive use, and the demand for it has always exceeded the supply. Most of the present supplies of Circassian walnut come from the shores of the Black Sea *via* Odessa, though large shipments are made from India. The tree adapts itself well to varying conditions of soil and climate, and is consequently one of the most widely distributed of commercial timber trees. In the United States the tree is cultivated solely for its nuts, and hence the timber produced is of little importance.

Technical Properties of Timbers.—The results of tests carried out on Western hemlock (*Tsuga heterophylla*) and Western larch (*Larix occidentalis*), to determine their mechanical and physical properties with a view to their more extensive utilisation, are given respectively in *Bulletins* Nos. 115 and 122, 1913, *Forest Service, U.S. Dept. Agric.* The tests were similar to those carried out by the Forest Service on structural timbers, previously noticed in this BULLETIN (1913, **11**, 358). In the case of both trees the test material employed was of two classes. Structural timbers, chiefly in the form of bridge stringers, with those defects commonly found in timber purchased on the market, were tested to determine the strength, and the effects of seasoning and of defects on the strength, and to compare the efficiency of grading rules and specifications; whilst small, clear pieces were used to study the influence on strength of weight, moisture, and rate of growth. The results of the tests show that the Western hemlock is suited for use in all but the heaviest constructional work, whilst both timbers are well adapted for building purposes, especially for framing, flooring, and inside finishing. In both *Bulletins* the results of the tests are tabulated and discussed.

Tanning Materials

Chestnut.—Attention is directed in the *Leather Trades' Review* (1913, **46**, 597) to the gradual disappearance of the chestnut tree from France. In 1882 this tree covered an area of 356,000 hectares, but the area has diminished since then by from 60,000 to 70,000 hectares. This diminution is ascribed chiefly to the considerable development in the manufacture of tanning extract, which accounts for a decrease of 1,400 hectares annually, and to the disease of chestnut trees known as "ink," or "blackfoot," which has occasioned the disappearance of chestnut trees over a surface of 4,000 to 5,000 hectares.

In some districts this has led to good results, for it has brought about an appreciable advance in the value of the land, due to the substitution of the culture of other more remunerative products than the chestnut. On the other hand, this disappearance has been unfortunate for those districts where the soil is unfit for more remunerative crops, and where the land has been cleared to such an extent that the surface soil has become washed away.

The conservation and extension of the chestnut forests are necessary for the production of the fruits, which are used in confectionery and as food, for the supply of raw material for the manufacture of tanning extract, for the consolidation of mountainous lands, and for increasing the value of otherwise unproductive lands.

The following measures, among others, have been proposed to remedy the present state of the chestnut forests: That all unproductive lands be planted with chestnut trees; that the chestnut forests be exploited judiciously and then re-stocked with carefully selected plants; and that bounties be offered for forestation with chestnut.

Mangrove.—Reference to the mangrove industry of Mozambique has been made already in this BULLETIN (1905, **3**, 351; 1907, **5**, 59; 1913, **11**, 171). Further information is given in the *Journ. Roy. Soc. Arts* (1913, **61**, 976), where it is stated that the trees are felled when between fifteen and twenty years old, and are logged to standard lengths varying with the diameter, *e.g.* 7 in. trees to 7 ft. lengths; 8 in. trees to 8 ft. lengths, etc. The bark is then stripped off, thoroughly dried, broken into chips, and finally packed in bags for shipment. If the mangrove trees are cut down a few feet above the ground they grow up again, while, if the tree is stripped of its bark without felling, it dies down.

Synthetic Tannin.—Eitner's experiments with "Neradol" (cf. this BULLETIN, 1913, **11**, 360) are described in the *Leather World* (1913, **5**, 699). He found this product to have a slightly acid reaction, which caused swelling in hides immersed in its solution. The tanning action depends but little on the concentration of the liquor, while strong solutions do not cause contraction of the grain. Details of working methods are given. It was found that thick hides could not be completely tanned with "Neradol" alone, but success was attained with lighter skins, especially those of loose texture, such as sheep skin. It can, however, be used for the fore-tannage of sole leather. "Neradol" is stated to accelerate tannage, improve the quality of the leather, give increased density, resistance, and weight, and to have a bleaching effect when used in conjunction with vegetable tanning materials. Eitner does not consider that this synthetic product is likely to replace vegetable tanning materials, but that it can serve as an excellent auxiliary.

Teri Pods.—The results of analyses carried out in the United States on "Teri" pods (*Cæsalpinia digyna*) show that the pod-cases examined contained 42·6 per cent. of tannin and 18·4 per cent. of non-tannins (*Journ. Soc. Chem. Ind.* 1913, **32**, 500). These pod-cases were therefore slightly less rich in tannin than most of the samples of this product examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 220). It is further stated that the leather given by this material is equal in colour to that from the best sumach, and does not darken appreciably on exposure to light for four weeks. It is recommended that the pods be leached whole, as it is considered that it will not pay to remove the seeds.

Wattle Bark.—The question of growing wattle trees in Western Australia has been taken up recently by the Woods and Forests Department of that State (*Ann. Rep. Woods and For. Dept. West. Aust.*, 1911–12, p. 4), and about 30 acres at the Ludlow Plantation have been sown with the seed of the broad-leaved golden wattle (*Acacia pycnantha*). A few experimental plantations had previously been formed with the purpose of encouraging settlers to plant the useless portions of their land with wattle, but so far no private landowners have done so. In various parts of the State there is land with poor soil where the conditions are favourable for wattle cultivation, and where the tree could be grown profitably. It is claimed that a successful plantation would produce 5 tons of bark per acre when the trees were fit for stripping, that is, when five or six years old, and that this yield would give a return of £25 per acre.

According to the *Leather Trades' Review* (1913, **46**, 630), an experimental consignment of 500 tons of wattle bark has been shipped from Natal to the United States, with the object of finding another market for the bark, which so far as Europe is concerned is at present almost exclusively used in Germany.

Resins

Indian Olibanum or Frankincense.—Previous experiments in tapping *Boswellia serrata* trees, the source of Indian olibanum, in the hot season, having given unsatisfactory results, fresh experiments have been made during the cold weather in the Siwalik Division of the United Provinces, India, particulars of which are given in the *Indian Forester* (1913, **39**, 196). The cold season was selected because it is in this part of the year that the gum-resin is collected in those districts which produce commercial supplies.

The trees were tapped by cutting a ring all round the trunk down to the wood, at a height of 5 ft. from the ground, and about one-half to two-thirds of the bark was shaved off below for a foot in width. Little gum-resin exuded from the first cut, but an improved flow was obtained on two occasions when the wounds were renewed. The yield per tree was found to vary considerably, but old, faulty trees with thick bark generally gave the highest yield. As a rule the best flow was obtained from the sunny side of the trees. It is concluded from these experiments that the ring of bark shaved off in the first instance need not be more than 3 or 4 in. wide, and that trees exude most gum-resin from old wounds. Gently hammering the bark above the cut seemed to slightly increase the flow. It is stated that this method of tapping cannot be the best, and that further experiments on the subject are required before definite recommendations can be made as to the time and method of tapping.

Lac.—The inoculation of "Kon" trees (*Schleichera trijuga*) in Ceylon with brood lac (see this BULLETIN, 1913, **11**, 360) has not been very successful owing to the insects having emerged from the infested sticks while in transit, and to the considerable damage done by pests (*Trop. Agric.*, 1913, **40**, 277). A sample of the resulting stick lac was reported by the Imperial Entomologist of India to be damaged mainly by predaceous caterpillars, and a living larva of *Enblemma coccidifraga* was found in the tunnels formed in the lac. Only a few cells were unaffected. A further cause of damage was stated to be a minute Hymenopterous parasite (*Chalcidæ*). Both these insects are known to cause damage at Pusa, especially in the June-October crop, the October-June crop being comparatively immune. The same conditions will probably prevail in Ceylon, but as the cultivation of lac spreads it is expected the damage from these causes will diminish.

It is suggested by the Imperial Entomologist that the inoculated trees be occasionally inspected, and all caterpillars destroyed in their tunnels, and in the pustule-like cocoons among the lac.

Turpentine.—The oleo-resins obtained in the course of tapping experiments on the Western pines of the United States (see this BULLETIN, 1913, **11**, 361) have been examined as to their chemical constituents, and the results of this investigation have been published in *Bulletin* 119, 1913, *For. Serv., U.S. Dept. Agric.* Although none of the oils obtained by the steam distillation of the oleo-resins agrees entirely in composition with standard American turpentine oil, there is no reason to doubt that these oils will serve for various industrial purposes.

The oil from the Western yellow pine of Arizona (*Pinus ponderosa scopulorum*, Engelm.) most nearly conforms to standard turpentine oil, and consists chiefly of α-pinene. It is thought that this oil and that from the Western yellow pine from California (*P. ponderosa*, Laws), which consists mainly of β-pinene, could be used as substitutes for ordinary turpentine oil, but practical tests are necessary to decide this point.

The oil from *P. edulis*, Engelm., contains cadinene, but this can be removed by re-distillation, the resulting oil consisting almost entirely of α- and β-pinene. The redistilled oil is very similar to ordinary American turpentine oil, but it still retains the characteristic odour of the cadinene residue, which might prove objectionable to the user. Digger pine (*P. Sabiniana*, Dougl.) yields an oil quite different from ordinary turpentine oil, and could not be used as a substitute for it. It consists almost entirely of heptane, and might be used in various industries as a cheap and useful solvent. Lodgepole pine (*P. contorta*, Loud.) and sugar pine (*P. Lambertiana*, Dougl.) give such small yields of oleo-resin that their volatile oils are not likely to become commercial products. The constants of the rosins from these various pines are also quoted in this *Bulletin*, but technical trials are necessary to determine whether they can be used in place of ordinary pine-rosin.

The possible markets for Indian rosin and turpentine oil, manufactured at the Government distillery, Bhawali, near Naini Tal, United Provinces, are discussed in a Report forwarded to the *Indian Trade Journal* by the Assistant Conservator of Forests, Naini Tal Division (1913, **29**, 260). Indian turpentine oil has, at present, the disadvantage of leaving a sticky residue, which causes the oil to dry slowly, and prevents it from replacing the American variety in the Indian markets. This residue is attributed by the author to the high temperature of distillation of the crude oleo-resin, and it is intended in future to use steam only for the distillation, and to redistil the oil thus obtained. The investigations made at the Imperial Institute on this oil, however, showed that the oil consists largely of a high boiling part, which oxidises very readily, forming syrupy products, and that whilst steam distillation and a re-distillation will improve the oil, there is no hope of getting rid of this part except by numerous re-distillations and sacrificing a large proportion of the oil (see this BULLETIN, 1912, **10**, 542).

As regards the markets for rosin, already contracts have been arranged for supplying certain paper-mills and soap-factories, while a consignment sent to varnish manufacturers has been reported on as satisfactory. It is stated that, as in the case of Indian turpentine oil, the question of a suitable packing material for the Indian rosin is a factor which to some extent prevents its more extended use. Wooden barrels and boxes will probably be found satisfactory.

Besides this distillery at Bhawali, which can work 100,000 maunds of oleo-resin annually (1 maund = 82·28 lb.), a new one is shortly to be started at Tanakpur, capable of working 20,000 maunds of oleo-resin per annum, while that at Lahore, which, up to the present, has been more or less experimental, will be developed in the near future, so as to treat 50,000 maunds of crude oleo-resin annually. It is considered, however, that with a growing Indian demand it is doubtful if there will ever be any available surplus for export.

ECONOMIC MINERALS

Gold.—In *Geological Survey, Bulletin* No. 2, 1913, *Southern Rhodesia*, H. B. Maufe, the Director of the Survey, gives an account of the association of gold deposits with acid igneous rocks in Southern Rhodesia. A large part of the territory consists of metamorphic rocks (schists, etc.), which lie in elongated belts of varying width flanked by broad masses of granite.

The rocks of the schist belts may be divided into three series, viz. (1) a series comprising greenstones and greenstone schists, banded ironstone with subordinate phyllites and limestones, and a group of conglomerates and grits; (2) a series of ultra-basic intrusions now represented by serpentine and talc schists, which contain chromite and asbestos; (3) a series of acid intrusions of varied character, consisting in the main of felsite or quartz porphyry, but frequently altered to a schistose condition.

Gold ores are found in each of these three series of metamorphic rocks, as well as in the granitic intrusions; but the results of work done up to the present appear to indicate that the ores are more particularly associated with the third series of metamorphic rocks mentioned above, *i.e.* the felsitic type. The distribution of two important groups of gold-reefs points to the existence of a probable genetic relation between the gold ores and the felsites. If this relation can be definitely established, a knowledge of it will be of importance to the prospector as a guide to the most likely areas of gold occurrence.

Iron Ore.—The Mines Branch of the Canadian Department of Mines has published a report by G. C. Mackenzie dealing with the magnetic iron sands of Natashkwan in the county of Saguenay, Province of Quebec (No. 145, Ottawa, 1912). These sands constitute one of the most promising of the black sand deposits of the Gulf of St. Lawrence. The treeless dune area at Natashkwan has been proved to contain at least 500,000 tons of magnetic iron ore concentrates, averaging 67 per cent. of metallic iron.

The ratios of crude sand to magnetic concentrate in the dune area were found to be about 10 to 1 for a concentrate containing 67 per cent. of iron, and 13 to 1 for a concentrate with an iron percentage of 70. From a crude sand containing 14·7 per cent. of iron and 4·43 per cent. of titanic acid, a concentrate containing 70·4 per cent. of iron and 1·7 per cent. of titanic acid can be prepared, and about 45 per cent. of the original iron is saved in the production of this concentrate.

The method proposed for the working of these magnetite sands is a combination of bucket dredges with Gröndal magnetic separators. An estimate is given of the cost of the plant that will be required to work the deposits by these means; and it is estimated that the cost of iron ore briquettes at Natashkwan harbour will be $2·7 per ton with a yearly output of 100,000 tons.

Monazite.—In a report by Messrs. E. Masillamani and I. C. Chacko, State Geologists of Travancore, dealing with work done during the years 1907–10, reference is made to the occurrence of monazite in that State.

The rocks of the State are almost wholly gneissic, the only exception being a narrow strip along the coast which is occupied partly by alluvium and partly by the sediments of the Varkkallai (Warkilli) series. This series is of Tertiary age; it is dominantly arenaceous, but includes some clay beds and also a bed of lignite.

Monazite occurs sparingly in the gneisses, but is more abundant in the veins of pegmatite that traverse them. From an examination of the alluvial deposits derived from the Varkkallai series, Mr. Chacko infers that the sediments of this series also carry monazite, which might be expected seeing that these sediments have been derived from the underlying gneisses. Confirmatory evidence that the Varkkallai beds contain monazite is provided by the result of an examination of a sample of ash obtained by burning the lignite that occurs in this series. A sample of this ash was examined at the Imperial Institute during the early part of 1910, and was found to contain monazite.

It is of interest to note also that at several places on the beach between Varkkallai and Anjengo there are accumulations of monazite sand that appear to have been formed by the disintegration of cliffs of the Varkkallai sediments.

Travancore thus furnishes a close parallel with Brazil, where monazite occurs in the gneisses of the interior as well as in sediments that form cliffs along the coast. In both cases the sediments forming these cliffs are being disintegrated by marine denudation, and the monazite is being naturally concentrated on the beaches by wave action.

The most important deposit in Travancore, north of Trivandrum, is stated to be that at the Ashtamudi Bar, where the sands are brought down by the Kallada river. The deposits at Cape Comorin are stated to be derived by disintegration direct from the gneisses.

According to the Director of the Geological Survey of India (*Rec. Geol. Surv. India*, 1913, **43**, 91), monazite has now taken an important place in the list of minerals of economic value produced in India. At present Travancore is the only locality in India where it is being worked. The output rose from 832 tons, valued at £24,044, in 1911, to 1,135 tons, valued at £41,419, in 1912. The mineral occurs as a constituent of the beach sands, from which it can be readily concentrated. For an account of the composition of monazite sand and monazite of Travancore, see this BULLETIN (1911, **9**, 103).

Phosphates.—In *Survey Department Paper* No. 30 (Cairo: Government Press, 1913), Dr. J. Ball gives a brief account of the phosphate deposits of Egypt.

Phosphate rock occurs in various parts of the deserts of Egypt, in sedimentary strata of Upper Cretaceous age. The chief localities where phosphate beds have been found are: (1) The Safâga District, near the Red Sea coast, about latitude 26° 30′; (2) the Nakheil District, near the Red Sea coast, about latitude 26° 10′; (3) the Qurn District, on the east side of the Nile, about latitude 25° 50′; (4) the Sibaia District, on both sides of the Nile, about latitude 25° 10′; (5) the Hamama District, east of the Nile, about latitude 26° 20′; (6) Kharga Oasis, in the Libyan Desert, 200 km. west of the Nile, about latitude 25° 30′; (7) Dakhla Oasis, in the Libyan Desert, 350 km. west of the Nile, about latitude 25° 40′.

Of these occurrences, two are being worked, viz. those of the Safâga and Sibaia districts. Up to 1912, Egypt's output of phosphate was small, and was all derived from the Sibaia district. Since then the output of the Safâga mines has become established, and these mines are now an important source of phosphate.

The mining of phosphate in Egypt began in 1908, in which year there was an output of 700 tons. In 1911 the output had grown to 6,425 tons, but in 1912 it reached 69,958 tons, and Egypt promises to become an important contributor to the world's production of phosphate. The phosphate is at present exported in a raw state, as there is no factory for the manufacture of superphosphate, and there is little or no local demand for the product. Should a local demand for raw phosphate arise, there appears to be plenty of material available for use that is rather too low-grade in quality for export.

In *Survey Department Paper* No. 29, Dr. Ball deals with the topography and geology of the phosphate district of Safâga, which is at the present time the most important of the various Egyptian phosphate districts enumerated above.

The Safâga deposits occur on either side of the Wadi Safâga, at distances from 12 to 22 km. inland. They occur in several isolated areas, of which the three principal are those of Um el Huetat, Mohammad Rabah, and Wasif.

The oldest rocks of the district are the fundamental granites, greenstones, etc. These are succeeded by Nubian sandstone, and overlying the latter there are Cretaceous and Tertiary sediments. The sedimentary rocks occur in basin-shaped depressions and are surrounded by hill masses made up of the igneous rocks. The areas covered by the sedimentary strata are approximately as follows: Um el Huetat, 60 sq. km.; Mohammad Rabah, 25 sq. km.; Wasif, 36 sq. km.; and it is estimated that the phosphate beds exist over about one-seventh of these total areas.

The phosphatic series of beds is in the Cretaceous; it consists of clays, phosphate, and chert, lying below beds of Upper Cretaceous limestone; and in the Um el Huetat basin, which is typical of the Safâga district, the series has a total thickness of about 45 metres, as follows:

(*a*) Phosphate bed No. 1 (1·8 metres).

(*b*) Chert beds with thin bands of hard phosphate (5 metres).

(*c*) Phosphate bed No. 2 (1·3 metres).

(*d*) Laminated grey clays (9 metres).

(*e*) Phosphate bed No. 3 (2 metres).

(*f*) Laminated grey clays (25 metres).

It has been found that the phosphate beds crop out wherever the lower limit of the Upper Cretaceous limestone is exposed, and they show a dip of about 13° towards the centre of the basin, though the dip is variable, being much less in some localities. The important mines are situated near the centre of the Um el Huetat basin.

The results of a large number of analyses indicate that the three phosphate beds contain on the average the following percentages of tricalcic phosphate: No 1, up to 60 per cent.; No. 2, 50 to 75 per cent.; No. 3, 20 to 45 per cent.

Mining operations on an extensive scale are at present confined to the Um el Huetat area, and to the middle or No. 2 bed, the richest of the three. Nearly all the phosphate exported from Egypt since the beginning of 1912 has been obtained from these mines, and at the time the report was written the daily output was about 300 tons of rock, containing 65 per cent. or more of tricalcic phosphate. The mines are connected by a private railway, about 20 miles long, with Port Safâga.

Tungsten Ore.—In a paper "On some Occurrences of Wolframite Lodes and Deposits in the Tavoy District of Lower Burma" (*Rec. Geol. Surv. India*, 1913, **43**, 48), Dr. A. W. G. Bleeck gives the results of two months' field-work among the tungsten-ore deposits of the Tavoy District.

The district is mountainous, with elevations up to 6,000 ft., and the general strike of the ranges is N.N.W.-S.S.E. It is mostly jungle-clad, with high forest and impenetrable undergrowth. The rainfall is very heavy, nearly 300 in. per annum, and most of the rain falls between the middle of April and the end of October. Hill streams and torrents, usually with perennial water, are very numerous, and deeply eroded valleys form a conspicuous feature in the district.

The rocks of the district are shales, sandstones, quartzites, schists, and intrusive biotite granites. Quartz veins are abundant in the metamorphosed rocks, and also in the granites near the outer margins of the intrusions. These veins vary from a fraction of an inch to 12 ft. or more in thickness. Where the veins occur in the metamorphic rocks, their strike is usually either coincident with, or at right angles to, that of the rocks. The veins that lie along the strike of the metamorphic rocks were observed to be more uniform in thickness, but poorer in quality, than those that cut across the strike of the beds.

Nearly all the veins observed were of the wolframite-quartz type. The wolframite occurs in scattered patches in white opaque quartz. Single crystals of wolframite up to 3 or 4 in. in length were observed, and massive aggregates of the mineral weighing as much as 90 lb. were found. The veins are, however, in some places barren over a considerable distance, a fact which made it impossible to estimate, even approximately, the ore-contents of the lodes. The characteristic feature of this normal type of lode is the predominance of wolframite over all other minerals except quartz. Columbite and tourmaline occur in all the lodes, and other associated minerals present in small amounts are molybdenite, bismutite, iron pyrites, copper pyrites, galena, and arsenopyrite. Cassiterite (tinstone) is rare, and fluorite (fluorspar) was not found.

In the Kalonta area two lodes were observed which differ from the predominant wolframite-quartz type. One of these is about 1 ft. thick and carries cassiterite in the form of grains not exceeding ¼ in. in diameter; but no wolframite was observed in it. Cassiterite also occurs as an accessory mineral in the granite.

A third type of lode observed at Kalonta was one containing muscovite in addition to wolframite and quartz. It was found in close proximity to the cassiterite lode, and also to others of the normal wolframite-quartz type.

Wolframite and cassiterite also occur in the surface detritus, *i.e.* hill-wash and stream deposits, and this type of occurrence is stated to be of considerable economic importance in the district, as it furnishes workable deposits where natural concentration has taken place in the vicinities of the lodes.

The Director of the Geological Survey of India, in his *Annual Report on the Mineral Production of India for* 1912, states that the output of wolframite in Burma was 1,671½ tons, which is 363½ tons in excess of the production for 1911. Most of this was obtained in Tavoy, but the output from Mergui was more than doubled, and rose to nearly 219 tons. The output of the mines in the Southern Shan States rose from 40 to 60 tons.

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NOTICES OF RECENT LITERATURE

The Malay Peninsula: A Record of British Progress in the Middle East. By Arnold Wright and Thomas H. Reid. With a map and fifty-one illustrations. Pp. 360, 8vo. (London: T. Fisher Unwin, 1913—*Second Impression.*) Price 10s. 6*d*. net; post free, United Kingdom 10*s*. 11*d*., abroad 11*s*. 3*d*.

Progress in the political and economic development of British Malaya has been so rapid in recent years that a work giving a comprehensive survey of the Peninsula, based to some extent on original research, is welcome. The authors of this volume, having had access to the records of the East India Company's operations in the Malayan sphere and to documents—"which hitherto have escaped attention"—concerning events that immediately preceded the occupation of Penang, when British rule was implanted, are in a position to describe how history was made in the Straits of Malacca; and their appreciation of the Colony and States—obviously from personal experience—is in strong evidence. The detailed historical retrospect is followed by interesting accounts of the Colony, the federated and the non-federated States, in which the economic aspect of these thriving settlements and Native States is fully developed. The importance of the Malay Peninsula for the production of tin and rubber, the influential share of the Chinese elements of the population in its commercial activities, and the British preponderance (90 per cent. of the European population) in the Federated Malay States, are characteristic features of this record. The chapter on rubber and other agricultural products is of special interest.

A Handbook for Travellers in India, Burma, and Ceylon. *Ninth Edition*. Pp. clxviii + 664, Crown 8vo, with seventy-nine maps and plans. (London: John Murray, 1913.) Price 20s.; post free, United Kingdom 20*s*. 4*d*., abroad 20*s*. 8*d*.

This is a complete revision of Murray's Handbook, the extent of which is indicated in the revised Preface, as follows: "In the present edition the general scheme of the Handbook has been maintained. Every portion of the Introduction has been carefully examined; many of the sections have been rewritten and corrected by the light of further knowledge; some new sections and maps have been added; the figures of the last census of 1911 have been adopted, wherever available—the general object has been to provide the best and newest information attainable regarding the country and places mentioned, the means of travel, and the sights best worth seeing." In the spelling of place-names, the system adopted—occasionally at variance with spellings on the maps—is admittedly a compromise, but one that, at least, has "official authority."

The introductory information contains general hints for the use of travellers, a description of the outward voyage, and a very valuable summary, giving information—statistical, ethnological, historical, archæological, and material—in regard to the country and its people. Bartholomew's maps and plans, beautifully reproduced, greatly enhance the value of this famous handbook, which is a model of what a handbook should be, as a book of ready reference supplying authoritative information.

MOZAMBIQUE: ITS AGRICULTURAL DEVELOPMENT. By Robert Nunez Lyne, F.L.S., F.R.G.S. Pp. 352, Demy 8vo. (London: T. Fisher Unwin, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 11*d.*, abroad 13*s.* 11*d.*

This book, which is intended primarily for investors and settlers, appears at a time when much interest is being taken in the development of East Africa—British, German, and Portuguese—and contains much information that will be of value alike to business men and prospective planters. Of the natural advantages possessed by Portuguese East Africa there can be little question. Mozambique (the author performs a useful service in defining the five designations of the word) is favourably circumstanced in regard to communications, transport, and accessibility of markets; and to these fundamental conditions for development may be added, large areas of fertile land situated near the coast and easily irrigated from slowly moving rivers. The author has an instructive chapter on the limiting factor of effective labour. It would appear that sparseness of population is the main cause of the scarcity of labour for agricultural purposes, and it is maintained that the recruiting of men for the Rand does not seriously affect the question for the planter. Contributing causes are the natural indolence of the people and the inexperience of white employers in the management of natives.

Based upon an experience of the country gained during his tenure of the post of Director of Agriculture, the author discusses the prospects of various branches of planting enterprise and gives many useful hints in regard to the culture of specific crops. Sugar and coconuts are established industries; for the development of the former it would appear that improved methods of cultivation and the use of labour-saving machinery are necessary; while in regard to coconuts the author is of opinion that the present areas planted are not first-class coconut districts. One of the chief problems in the development of the country is the future of rubber-planting. The question is discussed in a conservative spirit, but it would appear that the Ceara plantations of Quelimane and Inhambane are not without promise. The bulk of the rubber exported, however, is derived from the "root" of a Landolphia, probably *L. Kirkii*. The exploitation of the Landolphia forests for both stem and "root" rubber is dealt with, the author discussing the use of machinery for the production of larger quantities of a better-quality rubber. The Matadane forest is stated to be probably the only rubber forest on the east coast of Africa that is systematically worked. Other promising crops dealt with are Sisal, cotton, and tobacco, and there is an account of mafureira (*Trichilia emetica*) and jikungo (*Telfairia pedata*), two oil-bearing nuts already more or less well known. "Native" crops, *e.g.* maize, ground nuts, and rice, are briefly considered, and chapters are devoted to fruit-growing, lucerne, and vanilla. In the chapter on cattle-breeding and dairying it is pointed out that, in the tropical areas, cattle-raising will never be more than subsidiary to the planting industry. The district of Lourenzo Marques, however, is one of the best grazing countries in South Africa, its capacity being estimated at 800,000 head, while the present count is but 45,000 head (cf. this BULLETIN, 1913, **11**, 102). The area is now practically free from serious stock diseases, but in view of its serious consequences for the native cattle-breeder the author strongly criticises the policy of "slaughtering out" that was adopted to combat East Coast fever. For the investor there is useful information in regard to security of tenure in the country, and notes on the labour difficulty and fiscal questions. The main appendix consists of a translation of the Labour Law for the Mozambique Province (1909), and there is a useful map by Stanford.

BY THE EQUATOR'S SNOWY PEAK. By E. May Crawford. Pp. 176, Demy 8vo. (London: Church Missionary Society, 1913.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 3*s.* 2*d.*

A record of medical missionary work and travel in, perhaps, the most attractive district—Kenia Province—of British East Africa, under the equator, should make a wide appeal. The author and her husband, Dr. T. W. W. Crawford, had some interesting experiences in the course of their travels, and encountered many obstacles that were successfully overcome, at Weithaga, Kahuhia, Embu, and in the little known highlands beyond. The period covered was 1904–1912. The account given of the Akikuyu and other tribes is illustrated by some excellent photographs, and there is a coloured frontispiece, giving a view of Mount Kenia; but the block-map is all but useless.

The difficulty of overcoming native prejudice and of combating some objectionable customs—particularly Dr. Crawford's struggle with the witch doctor in Karbuti's village—is shown by the author to be far from insuperable; but much patience, tact, and firmness are required by those who attempt it. In that respect, a medical missionary has an additional advantage; and Mrs. Crawford's schools and Bible classes were well attended.

British Columbia in the Making, 1913. By John Bensley Thornhill, F.R.G.S. Pp. xiv + 175, 8vo. (London: Constable & Co., 1913.) Price 5*s.*; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

This book is avowedly written with a view to awakening interest in British Columbia as a field for the investment of capital. It gives a brief account of the history and development of the Province, and of its geography and climate, and then deals in a series of chapters with the transport facilities, the principal industries, and the possibilities of development.

Though the author has a good deal of criticism to offer regarding the financial side of certain phases of development in the Province, he takes on the whole a very sanguine view of the possibilities of the country. The book is quite useful as a statement of personal views based on actual experience of life under various conditions in the Province.

Twentieth Century Jamaica. By H. G. De Lisser. Pp. 208, 8vo. (Kingston, Jamaica: The Jamaica Times, Ltd., 1913.)

Apart from its general thesis this volume has little in common with the "handbook" that might be suggested by the title. The author has endeavoured to provide a picture of life in Jamaica at the present day, urging that no work on Jamaica, "written with intimate knowledge of the country and its people," has appeared for the last twenty years. The problem of the West Indies is one of great importance, and this book will be read with interest. The ten chapters are in the main concerned with the *people* of the Colony, their life as individuals and their hopes and aims as a community. Not the least interesting is that devoted to local politics and the ways of the Jamaican politician; the author has broken fresh ground in his vivid description of a tropical election.

The two most important chapters are probably the first and last, dealing respectively with "Jamaica's future with England, Canada, and the United States," and "Evolution and Progress." The author's views are sharply defined and lack no force of expression. He brings forward evidence to show that the darker elements of the population are destined to secure a social and economic position which would have been thought impossible a century ago, and that an improvement in the social and moral conditions of these people depends primarily upon the economic advance of the country. Such an advance is considered to be assured. The invaluable assets of an excellent soil and variety of climate, a fine system of roads, and a settled, industrious population, should be powerful factors in its accomplishment, but the great need is better markets. Canada and the United States are looked to by the author to furnish this *sine qua non*, and the political future of the country thus comes into question. This important matter is discussed in the first chapter, which affords conclusions that are not novel to students of colonial affairs in this country. The book is illustrated by interesting photographs, which, however, are of no special excellence.

The British Guiana Handbook, 1913. Containing general and statistical information concerning the Colony, its industries, manufactures, and commerce. Edited by Alleyne Leechman (of the Department of Science and Agriculture, British Guiana), and issued by the Permanent Exhibitions Committee under the direction of His Excellency Sir Walter Egerton, K.C.M.G. (Chairman). Pp. x + 283, 8vo. (Georgetown, British Guiana: "The Argosy" Co., Ltd. London: Dulau & Co., 1913.) Price 2*s.*; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 7*d.*

This volume forms a revised edition of the well-known "Handbook" issued by the Permanent Exhibitions Committee of British Guiana in 1909 (see this Bulletin, 1910, **8**, 333). In large measure the handbook has been re-cast, and now gives a remarkably concise and well-edited account of the present condition and resources of the colony; it is a book which, if widely distributed, should do much to arouse and advance interest in a comparatively little known country. The handbook as it now stands opens with an admirable introduction to the body of the work, which consists of five sections, dealing respectively with the country itself, its political organisation, resources, and opportunities for touring, while the final section comprises a statistical survey of the trade, finance, and meteorology of the colony, with information as to communications, postal facilities and allied subjects. The individual chapters are based on the articles contributed by specialists to the handbook for 1909. In the section on the country, the review of the geology of the colony is by Prof. J. B. Harrison, while Mr. F. A. Stockdale has re-written the chapter on climate, this latter article, together with that on hygiene, revealing re-assuring features probably unsuspected by those without personal knowledge of the country. The political section contains a concise statement of the Constitution, illuminated by an instructive "History of the Political Constitution," which traces events down to the changes effected in 1891. Local government, immigration, and education are dealt with, and there is a short chapter on the aboriginal "Buck" Indians. The most important section, viz. that devoted to the resources of the colony, has been revised by Mr. Stockdale. Preliminary chapters deal with the fauna and flora, the former contribution being made by the editor. The succeeding chapters on agriculture, forests, mining, and manufactures afford a most useful survey of the modern industrial condition of British Guiana, and indicate the lines along which development may be expected. The commercial man will find information regarding the ordinance under which Crown Lands may be leased for purposes other than mining, the regulations relating to the mining industries, and a copy of the "Mining (Mineral Oil) Regulations, 1912." There is also a statement in regard to the recent reciprocity agreement with Canada. The book is admirably printed, and reference must be made to the excellent photographs and map. The low price at which the volume is issued has probably stood in the way of a more substantial binding.

GUATEMALA AND THE STATES OF CENTRAL AMERICA. By C. W. Domville-Fife. Pp. 310, Demy 8vo. (London: Francis Griffiths, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 10*d.*, abroad 13*s.* 2*d.*

The author of this volume is already well known as an authority on Latin America through his books on *The Great States of South America* and *The United States of Brazil.* In the present volume this survey is continued by descriptions of the Central American States, Guatemala, Nicaragua, Costa Rica, Salvador, and Honduras. In each case a brief account of the history of the country is given, followed by descriptions of its present position, people, scenery, and typical features. Some reference is also made to the agricultural and mining industries of the countries and to their commerce and trade.

The increase in importance of the Central American States, which will be one of the results of the opening of the Panama Canal, will no doubt attract both the general and the commercial visitor to those territories in great numbers in the near future. To any one proposing to take such a trip, this volume will be of great value, but it should also appeal to all who are interested in the unique problems connected with the political development of these countries.

TWO YEARS WITH THE NATIVES IN THE WESTERN PACIFIC. By Dr. Felix Speiser. Pp. xii + 291, Demy 8vo. (London: Mills & Boon, 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 3*d.*

The natives of the Western Pacific visited by Dr. Speiser, and dealt with in this book, were those of the New Hebrides and some outlying islands of the archipelago between Banks Island and Tanna, including a visit to the little-known Santa Cruz Islands. It is a popular account of the routine life of the natives and of the experiences of an explorer who, under most discouraging circumstances, was determined to make their better acquaintance. In this Dr. Speiser succeeded in a remarkable degree; and he gives the reader a very vivid impression of the islands and peoples he visited, no less than an instructive view of the general situation which the Anglo-French Condominium is attempting—with little apparent success—to control. In particular, he lays stress on the laxity or absence of French supervision over methods of recruiting for labour and the liquor traffic; and he gives many instances of the deterioration and decimation of these savages—many of them cannibals—by disease, alcoholism, and contact with degenerate whites. This specially is noticeable on the island of Ambrym, where the natives—originally among the most vigorous and energetic tribes of the archipelago—spend all their money in drink, at least on the French side. "If," says Dr. Speiser, "the liquor traffic is not speedily suppressed, the population is doomed" (p. 201).

There are singularly few lapses of idiom—considering the author is interpreted in a foreign language—while passages descriptive of scenery and the war of the elements in this group of coral and volcanic islands are very effective. Exception may be taken to the use throughout the book of the metrical system of measurement, to which the general reader in this country is not accustomed. In a work otherwise so well illustrated and produced, one would have expected a suitable map, without which it is difficult to follow the author in his wanderings: the rough type-blocks, with German spellings, are all but valueless.

THE CONQUEST OF THE DESERT. By William Macdonald, M.S.Agr., Sc.D., Ph.D., D.Sc., F.R.S.E., F.G.S., Editor of the *Agricultural Journal*, Union Department of Agriculture, South Africa. Pp. xii + 197, Demy 8vo. With 50 illustrations. (London: T. Werner Laurie, Ltd., 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom, 7*s.* 10*d.*, abroad 8*s.* 1*d.*

The Kalahari is a desert tract in the centre of South Africa, 120,000 square miles in extent; the greater part lies in the Bechuanaland Protectorate, but the southern portion, extending from the dry bed of the Molopo river to the Orange river, forms the Gordonia District of the Cape Province. It is with this portion that the author deals; he gives an account of his travels in it, and a vivid description of the soil and conditions there. The area is 18,499 square miles, and more than two-thirds is unsurveyed waterless desert. Along the Orange river, and at some places where water is brought by irrigation canals, a good deal of farming is done. The neighbourhood of this river is very suitable for orange trees, and they are grown around Upington, the chief town of Gordonia, and at Kakamas, another irrigation colony. Here and there away from the river, at places where water can be got, there are farms where stock is raised. These farms are of enormous area, being 10,000 to 100,000 acres in extent; land in such places sometimes fetches about a shilling an acre. Water last flowed in the Molopo river in 1894, but was lost in the sand before it reached the Orange river. The existence of this dry river bed shows that the rainfall must formerly have been greater. Notwithstanding the deficiency of rainfall certain plants grow in the desert, such as the "bushman grass," which thrives on a rainfall of 3 to 10 in. per annum, and on which cattle get fat. Another stand-by is the tsamma melon, which affords water and food to the wandering natives and to travellers crossing the desert. The author points out how the conditions might be improved by afforestation, and how the land might support a considerable population by means of the "dry farming" methods of cultivation which are now attracting so much attention all over the world. The author believes that the Kalahari desert is underlaid with water, which can be utilised by boring. Extension of the railway from Prieska, which is 120 miles from Upington, is also needed.

RUBBER AND RUBBER PLANTING. By R. H. Lock, Sc.D. Pp. xi + 245, with 10 plates and also figures in the text, Crown 8vo. (Cambridge: at the University Press, 1913.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

The author of this book was, until recently, the Assistant-Director of the Royal Botanic Gardens at Peradeniya in Ceylon, a position which brought him into close relationship with the rubber-planting industry in the island. During his stay in Ceylon, Dr. Lock carried out, in conjunction with Mr. Kelway Bamber, a long series of tapping experiments on *Hevea brasiliensis*, the Para rubber tree, and was thus able to study the various scientific problems connected with the production of latex and the physiological effects of tapping the trees. The present book deals mainly with the Para rubber tree, and is based very largely on the author's personal observation of plantation methods in Ceylon and the results of his own experiments.

The first two chapters (pp. 1–37) are devoted to the history of the use and cultivation of rubber and to a short summary of the principal rubber-yielding plants, and are followed by two chapters (pp. 38–92) on the important subject of the physiology of latex production. In the latter chapters, which form the most important section of the book, Dr. Lock deals with the structure and functions of the vegetative organs, the different types of laticiferous tissue, the structure of the bark of Hevea, the effects of wounding the bark, bark renewal, etc., and then gives a summary of his tapping experiments on Para trees in Ceylon during the years 1908–12. These experiments related chiefly to the effect of tapping Para trees at intervals of from one to seven days, the points investigated being: the yields of latex and rubber, the duration of the yield, the relation of the yield to the amount of bark removed, the origin of latex, the seasonal variation in the flow of latex, the effects of over-tapping, the effect of tapping on the composition of the latex, etc. Very interesting results were obtained from these experiments, but as the data have been already published in Ceylon, and summarised in this BULLETIN (1911, **9**, 407; 1912, **10**, 495), no detailed notice is necessary here.

Chapters V. to VIII. (pp. 93–196) are devoted to a general account of the methods adopted in Ceylon for cultivating and tapping Hevea trees and for preparing the rubber. The diseases and pests which attack the trees are also described.

The cultivation of rubber-yielding plants other than *Hevea brasiliensis* is dealt with in pp. 197–209, and the remainder of the book (pp. 210–237) is occupied by an account of the chemistry of rubber and the manufacture of rubber goods.

The book gives within a convenient compass a useful account of the production of Para rubber in Ceylon, and also calls attention to the various scientific and technical problems which arise in connection with the rubber planting industry. These problems demand very careful investigation, as they may have an important bearing on the future of the industry, and the results of Dr. Lock's experiments, extending over four years, deserve study from this point of view.

The rubber-yielding plants other than *Hevea brasiliensis* are only very briefly dealt with, and in this section a few slips have been noticed. The generic names Forsteronia and Mascarenhasia are wrongly spelt both in the text and index; *Funtumia africana* and *Landolphia florida* are mentioned as rubber-yielding plants; and *Funtumia elastica* is stated to have been formerly known as *Kickxia africana*.

THE CHEMISTRY OF RUBBER. By B. D. Porritt, B.Sc. (Lond.), F.I.C., Chief Chemist to the North British Rubber Company, Edinburgh. Pp. vi + 96, Crown 8vo. (London: Gurney & Jackson, 1913.) Price 1*s.* 6*d.* net; post free, United Kingdom and abroad, 1*s.* 9*d.*

This little book can be recommended to all who desire to obtain a concise and trustworthy account of our present knowledge regarding the chemistry of rubber. Within the short limits of 96 pages Mr. Porritt has succeeded in giving an excellent survey of recent researches on the subject, including the work on the production of synthetic caoutchouc. The ground covered includes the properties of crude rubber; the constitution and derivatives of caoutchouc; the methods of vulcanisation and the theories which have been put forward to explain the change; waste rubber and its utilisation; and lastly, synthetic caoutchouc. A very good bibliography, to which references are given throughout the text, adds considerably to the value of the book.

THE PREPARATION OF PLANTATION RUBBER: A reference text-book for practical planters. By Sidney Morgan, A.R.C.S., F.C.S. Pp. x + 269, Royal 8vo. (London: The Rubber Growers' Association; no date.) Price 10*s.* net; post free, United Kingdom 10*s.* 5*d.*, abroad 10*s.* 9*d.*

The cultivation of *Hevea brasiliensis*, the Para rubber tree, on a very extensive scale under plantation conditions in the East, has given rise to a large number of problems connected with the methods of growing and tapping the trees and of preparing the rubber, and in the working of the estates practical difficulties are continually arising. These problems and difficulties demand careful scientific investigation on the spot as the first step for their successful solution, and, realising this fact, the Rubber Growers' Association inaugurated, three years ago, a scheme of research to deal with the questions which were then already arising in connection with the plantation industry. Mr. Sidney Morgan was chosen to conduct the investigations in the Federated Malay States, and the volume now under notice, which records the principal results of his work during the last three years, supplies conclusive proof as to the necessity and value of such research work.

The book is divided into five parts, each dealing with a separate branch of plantation work, viz. (1) field operations, including systems of planting, thinning out, tapping systems, collection and transport of latex, and general field work; (2) factory operations, including the preliminary treatment of latex, coagulation, preparation of sheet and crêpe rubber, drying and smoking of rubber; (3) machinery and buildings, including suggestions as to the choice of machines, and as to the construction of factories, drying and smoking houses, store rooms, etc.; (4) the finished rubber, including defects in crêpe, block, and sheet, the comparative strengths of the different forms of rubber; and (5) general, dealing with the preparation of pale crêpe as compared with smoked sheet, the comparative qualities of plantation and fine hard Para, the grading of plantation rubber, methods of packing, spraying mixtures and formulæ, soils and manuring.

The book is essentially practical in character, and supplies valuable information to planters on all the various points with which it deals. The sections devoted to the finished rubber will, however, probably be of the greatest general interest, as they include a study of the defects to which plantation rubber is liable, and the results of investigations as to the comparative qualities of the different forms in which plantation rubber is prepared. In the latter case the opinions are based on the results of vulcanisation tests carried out in this country by Messrs. Beadle and Stevens. A few examples of the points investigated with reference to the finished rubber will indicate the practical nature of the work which Mr. Morgan has carried out: the effect on the quality of the rubber of (1) diluting the latex with water, (2) using an excess of acid for coagulation, (3) adding a solution of sodium bisulphite to the latex in order to obtain a pale rubber; the effect on sheet rubber of rolling it soon after coagulation or after allowing it to stand over-night; the effect of rolling on the quality of crêpe rubber; the defects in sheet, crêpe, and block rubber due to stains, oil-marks, mechanical impurities, "spot diseases," or tackiness, etc. On all these topics Mr. Morgan gives very useful information, based on the results of his experiments.

Another very interesting section of the book deals with the comparative strengths of the different forms of plantation Para rubber, and of plantation Para and fine hard Para. On these important points the results obtained indicate that smoke-cured sheet is superior in quality, as judged by mechanical tests, to every other form of plantation rubber, and that, assuming smoked-sheet and pale crêpe to be at the same price, it is more profitable for an estate to produce smoked-sheet than pale crêpe. On the vexed question of the comparative value of plantation Para and fine hard Para the author gives the results of a large number of tests, which show that many samples of smoke-cured sheet are equal or superior to market samples of fine hard Para.

Mr. Morgan is to be congratulated on this record of very useful work ably carried out. The book is the most important contribution which has yet appeared on the practical details of rubber production from cultivated Para trees, and should be in the hands of every estate manager. The success which has attended this scheme of rubber research, inaugurated by the Rubber Growers' Association, is sufficient to justify its continuance on an extended scale, as such investigations cannot fail to be of the highest importance to the planting industry.

The Rubber Tree Book. By W. F. de Bois Maclaren. Pp. xvi + 307, with 85 illustrations. Royal 8vo. (London: Maclaren & Sons, Ltd.; no date.) Price 10*s.* 6*d.* net; post free, United Kingdom 11*s.*, abroad 11*s.* 6*d.*

This book forms a further addition to the literature on the subject of the cultivation of the Para rubber tree, and deals in some considerable detail with all the varied questions and operations involved in the working of plantations of the trees, from the acquisition of the land to the sale of the rubber. This is now well-trodden ground, but in his introduction the author states that "an endeavour is at least made to bring new light to bear upon rubber cultivation from various points of view which have hitherto received little or no attention. The endeavour is also made to arouse the interest of the planter in the soil he cultivates and the trees he grows there by showing how varied and wonderful are the phenomena connected therewith. When interest is thus aroused, then work becomes congenial, habits of closer observation are stimulated, and the tendency is, therefore, towards increased efficiency. . . . To assist in obtaining better results than have been secured in the past, to achieve these on more economical lines, and with a greater regard than has hitherto been shown for the future welfare of the rubber-growing industry viewed as a permanent investment, is the object with which this book has been written."

The book has certainly a claim to novelty amongst books dealing with rubber cultivation, in that it is embellished with quotations from, or references to, a large number of authors, including Chaucer, Pope, Wordsworth, Tennyson, Kipling, Darwin, Huxley, Sir Oliver Lodge, "the Hon." A. J. Balfour, Defoe, Disraeli, Oliver Wendell Holmes, Carlyle, and Bergson.

The attempt to interest the planter and his assistants in their work is also made on novel lines. The assistant in a rubber factory is thus addressed: "Let such an assistant consider a few—a few only—of the facts in front of him. He casts a careless eye upon the iron rubber-washing mill in front of him. He sees it. Why does he see it? Because the particles of which it is composed vibrate at not less than four hundred billion times a second. Did they vibrate at a slower rate he could not see the mill. Did they vibrate at a rate more than twice as fast the mill would again be invisible. Here have been at once raised a legion of the hows and whys which occupy the constant attention of the greatest scientific minds of the century." Even these questions are, however, not sufficient for our author, who proceeds: "Next let the assistant we have supposed have his attention aroused in this way to consider—What is matter? . . . What is an atom? . . . Thus an intelligent assistant can inspire his daily task." We must confess, however, that we feel a little doubtful as to the number of factory assistants in the tropics who will respond to the stimulus which Mr. Maclaren has so kindly provided for them.

On the general questions of estate procedure and management Mr. Maclaren is more practical, and the information he supplies is usually trustworthy. The book is well got up, and the illustrations are both numerous and good.

THE CABINET TIMBERS OF AUSTRALIA. By R. T. Baker, F.L.S. No. 18 of the Technical Education Series, Sydney Technological Museum. Published by the authority of the Government of the State of New South Wales. Pp. 186, Crown 4to, oblong, with 68 coloured, and many other illustrations. (Sydney: Government Printer, 1913.)

The author states in his preface to this volume that it was written with the desire to produce among Australians a better appreciation of Australian forest wealth, and also with the object of calling attention to the fact that some of the trees yielding the most beautiful of Australian woods are in danger of being exterminated owing to the rapid advance of the settler and the consequent destruction of forest. The volume should abundantly serve these purposes. It was a happy idea to invoke the aid of colour photography in representing these woods, by which means their beauty and ornamental character are clearly and accurately depicted. The grain and figure of such timbers as Yellow Wood, Crowsfoot Elm, Black Bean, Tulip Wood, Blackwood, and Red Cedar lend themselves admirably to this method of reproduction. There is a concise description of each timber figured, the botany of the tree and its geographical range, as well as a general account of the ornamental timbers of Australia from the cabinet-maker's point of view. There are also numerous illustrations in black and white showing how many of the woods are employed for interior fittings and furniture, though some of these would have been seen to better advantage in their natural colours. In the final chapters lists of timbers suitable for various kinds of cabinet-work are given, as well as a summary of the characters of the timbers dealt with. These add considerably to the value of the book, which will be welcomed by all interested in timbers and in forest preservation.

The Fermentation of Cacao, with which is compared the Results of Experimental Investigation into the Fermentation, Oxidation, and Drying of Coffee, Tea, Tobacco, Indigo, etc., for Shipment. Edited by Harold Hamel Smith, with a Foreword by Sir George Watt, C.I.E., M.B., C.M., LL.D. Pp. lvi + 318, Crown 8vo. (London: John Bale, Sons & Danielsson, Ltd., 1913.) Price 10*s.* net; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 6*d.*

This book consists of a series of articles on cocoa fermentation by well-known experts. In a preface by the editor, the source and scope of these various essays is indicated, attention is directed to the by-products of cocoa fermentation and their possible utilisation, and emphasis is laid on the need for Government assistance in financing institutions for giving instruction in the principles and methods of tropical agriculture.

The essays are published in the following order: (1) A translation, which first appeared in *Tropical Life*, of an article by Dr. Axel Preyer in *Der Tropenpflanzer* (1901, **5**, 157). (2) An article by Dr. Oscar Loew, reprinted from *Bull.* No. 1,093, *Office of Experiment Stations*, *U.S. Dept. Agric.*, which was originally published in the Annual Report of the Porto Rico Experiment Station for 1907. This paper deals with the fermentation of coffee as well as that of cocoa. (3) A translation of an article by Dr. Fickendey, Director of the Experiment Station, Victoria, Kamerun, originally contributed to *Der Tropenpflanzer* (1909, **13**, 87). (4) A translation of an essay by Dr. A. Schulte im Hofe, first published in Berlin in 1908, which, whilst dealing chiefly with cocoa, contains notes on the fermentation of coffee and tobacco. (5) A translation of an article by Dr. J. Sack. (6) A joint essay by Mr. George Hudson and Dr. Lucius Nicholls, which was awarded the prize in a competition arranged under the auspices of *Tropical Life*. The first part of this essay is written from the practical point of view by an experienced planter, whilst the second gives an account of the nature of the fermentative process and the changes which occur during its progress. The whole subject is summed up by the editor in a chapter entitled "The Last Word," and the opinions expressed by the various authors are compared and discussed. This is succeeded by the final chapter, consisting of a few notes by the editor on the curing and fermentation of tobacco.

The volume is well illustrated, and should be of considerable assistance to cocoa planters in enabling them to carry out the preparation of their crops in a scientific manner, and thus ensure their arrival at the factory in a satisfactory condition.

PLANTATION WHITE SUGAR MANUFACTURE. By W. H. Th. Harloff, Manager of the Boedoeran Sugar Factory, Java, and H. Schmidt, Consulting Sugar Chemist and Engineer, Java. Translated from the Second Revised Dutch Edition by James P. Ogilvie, F.C.S. Pp. vii + 138, 8vo. (London: Norman Rodger, 1913.) Price 7*s*. 6*d*. net; post free, United Kingdom 7*s*. 9*d*., abroad 7*s*. 10*d*.

The original Dutch edition of this manual, issued under the title of *Handleiding voor Tropische Witsuikerfabrikatie*, has met with such a cordial reception in Java that it was deemed desirable to extend its circulation among English-speaking sugar producers.

The object of the work is to afford an insight into the practical methods of the manufacture of cane sugar and the machinery required for the purpose, and to furnish an explanation, based on theoretical principles, of the various processes adopted.

The book is divided into two parts, the first giving a brief account of the chemistry of the subject, and the second dealing with the actual operations carried out in the course of manufacture. In the former section, consideration is devoted to the influence of alkalis, alkaline earths, acids, and of heating, on the constituents of cane juice, and reference is made to the colouring matters contained in the juice and those produced during the manufacturing processes, and to the different kinds of fermentation which may occur in the sugar factory. The second part of the book discusses the two methods of clarifying the juice, viz. carbonatation and sulphitation, and the treatment of the concentrated juice and syrups. The various processes are lucidly explained, and many valuable hints are supplied.

The work is written in a clear and interesting manner, and will doubtless prove a valuable aid to sugar manufacturers in tropical countries.

THE VOLATILE OILS. By E. Gildemeister and Fr. Hoffmann. Second edition by E. Gildemeister. Volume I. Authorised translation by E. Kremers. Pp. 667 + xiii, Med. 8vo. (London: Longmans, Green & Co., 1913.) Price 20*s*. net; post free, United Kingdom 20*s*. 6*d*., abroad 21*s*. 4*d*.

The previous edition of this work, of which the English translation appeared in 1900, has long been considered one of the standard works on the subject. This edition, which was published in German in 1910, is on the same lines as the previous one, but is, as might be expected, much expanded and revised to include the results of the large amount of work which has been done in connection with volatile oils during the last decade. Section 1, dealing with the history and development of the volatile oil industry, has naturally suffered the least alteration. Besides a general historical account it includes short paragraphs dealing with the more important individual oils and traces the development of the methods of distillation and apparatus employed from the early days of the industry to the present day.

The second section deals with processes other than distillation which are employed in special cases for the extraction of perfumes, viz. enfleurage and extraction with hot and cold solvents. Explanatory diagrams are included.

The important subject of the constituents found in volatile oils and synthetic perfumes is dealt with in section 3. This section is complete and concise. Details are given of the properties and derivatives of each compound, and of the methods best adapted for their identification.

The last section treats of the general methods adopted for the examination and analysis of volatile oils. Directions for the detection of commonly occurring adulterants are given. Two sets of tables for the calculation of the ester and alcohol contents of oils are included at the end of the book, one bound into the volume and the other, a separate booklet for laboratory use, inserted in a pocket in the back cover.

An unfortunate number of misspellings occur, and the translation in some cases is rather too literal, but defects such as these cannot detract greatly from the usefulness of such a complete and up-to-date treatise. The name of Messrs. Schimmel & Co., under whose auspices the book is published, is a sufficient guarantee of the accuracy and reliability of the information contained in it.

ARBEITEN AUS DEM PHARMAZEUTISCHEN INSTITUT DER UNIVERSITÄT BERLIN. Vol. X. Edited by Prof. Dr. H. Thoms, Director of the Institute. Pp. viii + 220, Med. 8vo. (Berlin and Vienna: Urban und Schwarzenberg, 1913.)

This volume consists chiefly of the reports on the various investigations in which the Pharmaceutical Institute of Berlin University was engaged during 1912. The work described includes the examination of drugs and secret remedies, researches in organic chemistry, a study of certain microchemical reagents and their application, and the investigation of various technical products derived from the German Colonies. Many of these reports have been published already in various chemical and pharmaceutical periodicals. The reports indicate that the Institute has a wide sphere of usefulness and that its operations are being maintained at a high level.

THE CHEMISTRY OF DYEING. By John K. Wood, D.Sc. Pp. ii + 80, Crown 8vo. (London: Gurney & Jackson, 1913.) Price 1*s.* 6*d.* net; post free, United Kingdom and abroad 1*s.* 9*d.*

This book gives a concise account of the present state of knowledge of the principles of dyeing, and is intended for the use of students who already possess some knowledge of organic and physical chemistry. The work is divided into three sections. The first deals with the chemical composition and general structure of fibres, whilst the second gives a classification of dyes, based on the methods of applying them. In the third section, the various theories which have been put forward to explain the nature of the dyeing process are reviewed, the degree of validity of each is indicated, and it is shown that any satisfactory theory must embrace the two processes of absorption and fixation. A useful bibliography of the subject is appended.

DOCUMENTS POUR L'ÉTUDE DE LA GÉO-BOTANIQUE CONGOLAISE. Par É. de Wildeman. Extrait du Tome LI du Bulletin de la Société Royale de Botanique de Belgique: 2^e Série, T. 1, Volume Jubilaire, 1912. Pp. 404, Imper. 8vo. (Bruxelles: 1913.)

On the occasion of the celebration of the fiftieth anniversary of the founding of the Société Royale de Botanique de Belgique, M. de Wildeman has produced a volume which reviews, in broad features, the present state of knowledge in regard to the flora of the Belgian Congo. His selection of a subject is happy no less on botanical than on national grounds, for the men whose names will always be associated with the botanical exploration of the Congo—Dewèvre, Laurent, and de Wildeman—have worked as prominent members of the Society whose jubilee is celebrated. The work of these and other African botanists has greatly advanced our knowledge of the œcological circumstances of central Africa. The author, however, regards the problems as still far from completely elucidated, and as offering great attractions to new workers. The popular conception of central Africa, and more especially the Congo, as a vast area of dense, virgin forest warranting an almost literal acceptance of the term "Darkest Africa," must give way in face of the results achieved by a more complete exploration of the country. The idea of an impenetrable forest arose from reports of earlier travellers whose journeys into the heart of Africa were made *via* the great rivers which afford a natural means of approach. The dense gallery forests of the river valleys which constituted the great botanical feature of these pioneer journeys came to be popularly regarded as typical of the whole region, a view that proved wholly inaccurate in the light of journeys made across the general direction of the river courses. It is now well known that the Congo region is not uniformly forested, but presents several distinct types of vegetation, the most important being forest, bush, savannah, and swamp. M. de Wildeman points out that, as in other parts of the world, the main types of vegetation may present different aspects in different regions, a fact clearly recognised by the native peoples not only in Africa but elsewhere. This fact is well illustrated in regard to the "tropical forest" which by the Congo natives is differentiated as "bwange," "sufa," and "pongbo" under varying conditions.

The author's classification (1908) of the Congo region into seven botanical zones is discussed in its relations with Engler's elaborate analysis of the African flora. In their main features, de Wildeman's conclusions appear to receive justification, but the author recognises the advisability of certain modifications—chiefly in the direction of elaboration—and in the revised form his classification provides for two great botanical "provinces," the "Province of the Guinea forest," and "Province of the south and east African steppes." The vegetation of the former is studied in regard to seven "districts," which may be conveniently distinguished under geographical headings, while the latter comprises the associations of certain central African lakes, and the regions of Luapula, Banguelo, and other areas. This classification forms the framework upon which the present volume is built up. The districts are dealt with in eleven chapters, in which discussion of the geographical and botanical features of the area is supplemented by classified lists of the species recorded therefrom. The text is illustrated with numerous photographs, drawings, and maps, several of which are familiar from their appearance in earlier works of the author. Two questions dealt with by M. de Wildeman may be mentioned as possessing an interest which will not be monopolised by professional botanists, viz. the influence of man (black and white) upon the botanical configuration of the country; and the question of the origin of the central African flora. The author is of opinion that man has played an important part in modifying the geographical occurrence of the botanical associations, not only in his rôle as an agent of destruction, but his conscious or unconscious introduction of species "new" to a district. In regard to the origin of the flora, it is pointed out that there is strong indication of a multiple derivation—a contention supported by interesting tabulated evidence.

CEMENT, CONCRETE, AND BRICKS. By Alfred B. Searle. Pp. xi + 412, Demy 8vo. (London: Constable & Co., Ltd., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 5*d.*

In this useful book the author has succeeded in producing a clear, concise, and up-to-date account of the main facts relating to the nature and manufacture of Portland cement, concrete, and bricks.

After a description of the various raw materials for cement, and a short account of the methods of manufacture, the author gives in detail the theories of W. and D. Asch concerning the structural formulæ of clays, and the molecular changes that take place on heating. According to these authors, Portland cement is not a mixture of silicates and aluminates of lime in solid solution, but a mixture of calcium alumino-silicates of highly complex constitution. Graphic formulæ are given, illustrating the constitution of these calcium alumino-silicates, and the changes that take place during the setting and hardening of cement. Methods of testing cements are dealt with in a comprehensive manner, and recent developments in apparatus, such as Nicol's Spissograph, and Schüle's machine for transverse bending tests, are described.

The section on concrete includes descriptions of the nature and proportions of the components used, and the methods of mixing and placing the concrete. Detailed accounts are given of the various systems of reinforcement, and the special properties of concrete with reference to its use as a building material. Emperger's loading test on specially prepared concrete beams is also dealt with.

The author classifies clays for brick-making according to physical characters and not according to chemical composition. The chapter on methods of brick making and burning is comprehensive, and rich in illustrations. Chapters are devoted to the classification of bricks, the manufacture of lime sand bricks, and in the concluding chapter there is a brief account of magnesite, bauxite, and chromite bricks.

The book is well written, practically free from errors and misprints. It is provided with a good index, and can be recommended as a good text-book.

DIE DYSENTERIE: Five popular lectures on its nature, prevention, and self-treatment in the case of Europeans and coloured people in the tropics. By Prof. Dr. Ludwig Külz, Government Physician. Deutsche Tropen-Bibliothek, vol. vii. Pp. v + 64, Demy 8vo. (Hamburg: Fr. W. Thaden, 1913.) Price 2 marks; post free, United Kingdom and abroad, 2*s.* 3*d.*

This is a companion volume to that dealing with malaria and black-water fever, already reviewed in this BULLETIN

(1913, **11**, 696), and it is likely to prove equally useful to residents in the tropics who can read German. The life history of the bacilli and amœbæ that give rise to the two forms of dysentery is clearly described, and excellent advice is given for the prevention of the spread of the disease, including some useful suggestions for preserving the water supply from contagion. The author recommends boiling for ten minutes as the only sure method of obtaining drinking water free from disease germs, preferring it even to the best porcelain filters. Such prolonged boiling is not, however, generally considered necessary, and it is so difficult to get natives or even Europeans to take hygienic precautions that it seems undesirable to make them more stringent than is absolutely imperative.

The directions for self-treatment, and especially those dealing with the important subject of diet, are all that could be desired. The author advises his readers strongly against the use of alcoholic drinks in the tropics, recommending in their place fruit syrups, tea, or cocoa.

The concluding pages deal with the hygiene and medical treatment of natives in the service of Europeans, and include a number of suggestions, the fruit of the author's personal experience, which deserve very careful consideration by the administrators of our tropical colonies and dependencies.

VON DER HEYDT'S KOLONIAL-HANDBUCH. JAHRBUCH DER DEUTSCHEN KOLONIAL- UND UEBERSEE-UNTERNEHMUNGEN. Edited by Franz Mensch and Julius Hellmann. Pp. xlviii +382, 8vo. (Berlin, Leipzig, and Hamburg: Verlag für Börsen- und Finanzliteratur A.-G., 1913.) Price 6 marks; post free, United Kingdom 6*s.* 5*d.*, abroad 6*s.* 9*d.*

In this the seventh annual edition of the handbook, the particulars with reference to the various undertakings and public companies in the German oversea possessions have been brought up to date, but the general arrangement is the same as that of previous issues (see this BULLETIN, 1909, **7**, 138; 1910, **8**, 102, 437; 1911, **9**, 325; 1912, **10**, 526). The growing interest which is being taken in the German colonies renders the work of increasing value.

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